STATE- OF-THE- STATE OF TEXAS

RETENTION OF HIGH SCHOOL SCIENCE TEACHERS

A Dissertation

by

SARA ELIZABETH SPIKES

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

August 2011

Major Subject: Curriculum and Instruction

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Approved by:

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ABSTRACT

State-of-the-State of Texas Retention of High School Science Teachers.

(August 2011)

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Chair of Advisory Committee: Dr. Carol L. Stuessy

Concerns regarding turnover of highly qualified science teachers have pervaded education stakeholder discussions for several years. Yet little is known about *where are we* in retaining high school science teachers in Texas public schools. The three empirical studies included in this dissertation used mixed research methods to explore data collected by the Policy Research Initiative in Science Education (PRISE) Research Group during the 2007-2010 school years.

The first study examined mobility patterns and hiring patterns of high school science teachers after two school years. I used descriptive statistical analyses to investigate relationships between teacher-level variables (i.e., teacher type, age, ethnicity, and gender) and school-level variables (i.e., school size and minority student enrollment proportion) with respect to movement out of and into Texas schools. Findings revealed variations in mobility patterns of science teachers, based on size and minority student enrollment proportion of the schools in which they worked. Hiring patterns revealed that schools typically hired young, novice White female teachers regardless of school size or minority student enrollment proportion.

The second study explored the relationships between schools' retention strategies and retention challenges with schools' science teacher retention rates, respectively. I used multiple regression and descriptive statistical analyses to investigate the relationships between study variables. While regression models predicting science teacher retention were not remarkable, descriptive statistical analyses revealed notable relationships between several school-level variables and school retention status.

The third study investigated relationships among three variables: school retention strategies, science teacher job satisfaction, and science teacher mobility. Multilevel analyses were used to investigate relationships between two-level variables. Findings revealed no relationships of significance between school retention strategies or teacher job satisfaction with teacher mobility. However, interactions between predictor variables indicated that satisfied science teachers were more likely to remain at schools that expressed and showed appreciation for teachers than to leave the profession.

Findings from these studies were used to make state-, district-, and school-level policy recommendations for high school science teachers that included: (a) tailoring recruitment and retention supports to meet the needs of underrepresented teacher populations leading science classrooms, (b) recognizing schools that successfully retain science teachers, and (c) providing professional development for high school principals to assist with the design of strategic plans to improve job satisfaction and retention of teachers.

DEDICATION

I would like to dedicate this work to my parents, Billy and Deborah Spikes Sr., and my brothers, Billy Spikes Jr. and Cory Spikes, for their prayers, encouragement, and faith in me. I would also like to dedicate the time and efforts of this work to the rest of my family and friends. I hope completion of this work will be encouragement to them that taking on such an endeavor is possible. I would especially like to dedicate this work to my niece, Abril Spikes, who reminds me every day what is most important in life.

ACKNOWLEDGMENTS

I would like to thank my committee chair, Dr. Stuessy, my committee members, Dr. Lewis, Dr. Loving, and Dr. Scott, as well as Dr. Kwok, for their guidance and support throughout the course of this research.

Thanks also go to my friends and colleagues and university faculty and staff for making my time at Texas A&M University a great experience. I also want to extend my gratitude to the National Science Foundation, which provided the support for my research and to all the Texas high school science teachers and their principals who were willing to participate in the study.

Finally, I would most like to thank God for helping me carry this cross. Thanks also go to my family, closest friends, as well as the spiritual guidance received from St. Mary Catholic Center in College Station, for their support and encouragement as I complete this endeavor and move on to the next.

NOMENCLATURE

MSEP	Minority Student Enrollment Proportion
PEIMS	Public Education Information Management System
PRISE	Policy Research Initiative in Science Education
SBEC	State Board of Educator Certification
TEA	Texas Education Agency
TPC	Teacher Professional Continuum

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CHAPTER I

INTRODUCTION

Despite years of national and state level reform efforts to improve science education, the verdict remains: “most Americans are not science-[proficient]” (e.g., American Association for the Advancement of Science [AAAS], 1990, p. xv). Findings of the National Assessment of Educational Progress (NAEP) have confirmed the average American student does not achieve proficient levels in science (National Center of Education Statistics [NCES], 2006). Furthermore, the average Black or Hispanic student does not even achieve basic competency levels that denote “partial mastery of the knowledge and skills that are fundamental for proficient work [in science]” (NCES, 2006, p. 6). Students’ knowledge deficiencies in science indicate inadequacies in the United States [U.S.] public education system. Inadequacies in science education forecast limitations students will experience as they attempt to “compete, prosper, and be secure in the global community of the 21st century” (National Academy of Sciences [NAS], 2007, p. 109).

Reformers in science education identify science teacher turnover as a significant, mitigating factor associated with the inadequacies and inequalities in the U.S. public education system. Decreasing teacher turnover rates has been the focal point of discussions among policy makers and education stakeholders for several years (Elfers,

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This dissertation follows the style of *Educational Administrator Quarterly*.

Plecki, & Knapp, 2006). Of most concern are research studies that suggest an inverse relationship between high teacher turnover rates and student science achievement (Levy, Fields, & Jablonski, 2006). While other outcomes associated with high teacher turnover rates are also of concern, research findings clearly indicate the educational significance of teacher retention in producing students who are proficient in science and prepared to take the next steps in terms of post-high school preparation for science-related jobs (NAS, 2007).

As such, science education stakeholders and policy makers are challenged to re-evaluate the current state of retention for high school science teachers. Both groups must distinguish what is important to achieve two, intertwined goals: (1) support an education system that focuses on the preparation and retention of expert science teachers and (2) educate and develop competitive science-proficient students.

Summary of Literature Review

Bandura's model of reciprocal determinism provides a contemporary perspective on science teacher retention. The theory of reciprocal determinism centers on the triadic interaction between cognitive, behavioral, and environmental factors, which act as determinants of each other (Bandura, 1977, 1978). Figure 1.1 shows how I fit variables associated with the retention of high school science teachers into Bandura's reciprocal determinism model. Using the school as a unit of analysis, I examined how these variables stimulate, respond, and reinforce one another (Bandura, 1978).

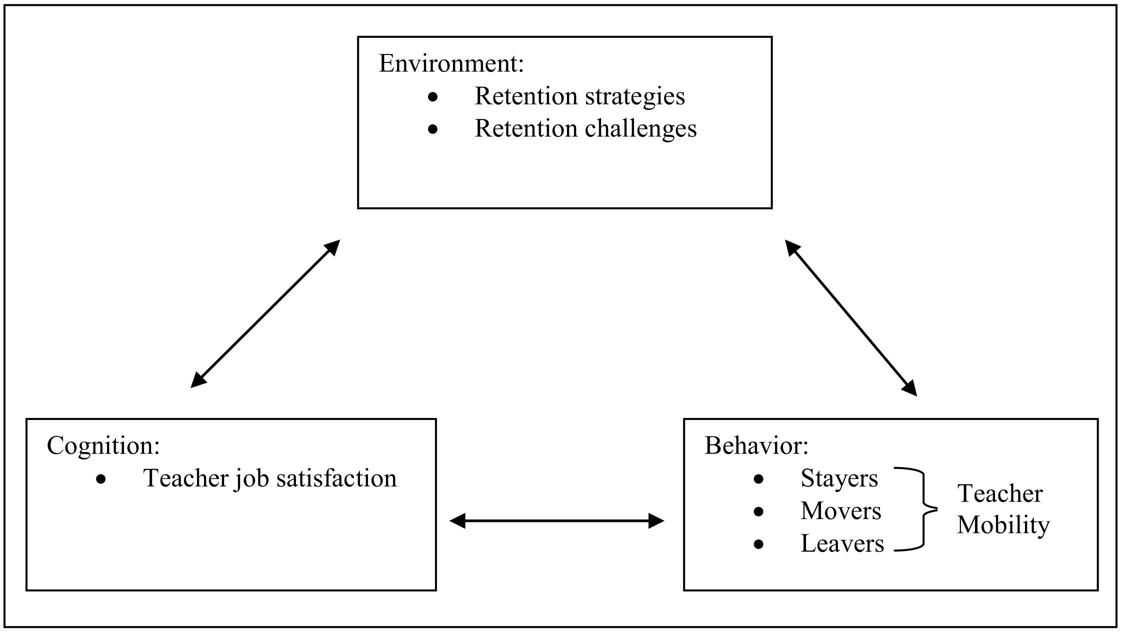

Figure 1.1 Schematic depicting how variables of interest fit into reciprocal determinism. Adapted from "The Self System in Reciprocal Determinism," by A. Bandura, 1977, *American Psychologist, 33*(4), p. 345.

Environmental Factors: Retention Strategies and Retention Challenges

Many studies have examined the relationship between school environment factors and science teacher retention (e.g., Borman & Dowling, 2008; Brown & Wynn, 2009; Charlotte Advocates for Education [CAE], 2004; Hanushek, Kain, & Rivkin, 2004; Ingersoll, 2001, 2003; Kain, Rivkin, & Hanushek, 2004; Kirby & Grissmer, 1993). Whether or not these factors improve or pose a challenge to teacher retention will depend upon administrative decisions, policy implementation, and finances.

The literature has suggested schools that provide strong administrative support, competitive salaries and benefits, adequate science facilities, and student discipline support are successful in retaining teachers (Bemph, Kaylen, Osburn, & Birkenholz, 1994; Brown & Wynn, 2009; CAE, 2004; Weiss, 1999). In addition, affluent schools with high achieving, predominantly White student populations typically have higher rates of teacher retention (Lankford, Loeb, & Wyckoff, 2002; Scafidi, Sjoquist, & Stinebrickner, 2007). However, despite these important findings it remains unclear (a) if these factors are utilized as specific strategies for teacher retention, (b) the extent to which these strategies are applied at the school-level, and (c) if variants of each strategy are better suited to specific school contexts (Knapp, 2003). Furthermore, the relationship between these factors and teacher retention provides superficial insight into the challenges schools experience for retaining science teachers.

Cognitive Factors: Teacher Job Satisfaction

A review of the literature has also indicated school environment factors (e.g., administrative support, working conditions, and wages) that are associated with science teacher retention are also likely to be associated with job satisfaction among science teachers (e.g., Butt & Lance, 2005; Huang & Fraser, 2009; Ingersoll, 2001; Ingersoll & Perda, 2009; Skaalvik & Skaalvik, 2009; Stockard & Lehman, 2004). The cognitive and affective processes (Huitt & Cain, 2005) teachers undergo as they consider their level of job satisfaction is an important component of reciprocal determinism. However, because dissonance exists between principals' perceptions and teachers' satisfaction about the quality of school policies, examining the relationship between school environment factors and job satisfaction warrants further investigation.

Behavioral Factors: Teacher Mobility

There are several research studies that investigate the mobility of teachers (e.g. Elfers et al., 2006; Hanushek et al., 2004; Ingersoll, 2001). “Teacher mobility [may be considered an] inclusive term for outcomes of teacher employment, including retention, attrition, and migration” (Bozeman, 2010, p. 3). So far mobility research has allowed science education researchers and policy analysts to determine the movement and distribution of the science teacher workforce. Common among studies has been the U-shaped pattern, which has suggested high turnover rates occur among young, novice teachers in their first few years of teaching and older, experienced teachers approaching retirement (Darling-Hammond, 2000; Grissmer, Kirby, Schlegel, Young, 1992; Guarino, Santibanez, & Daley, 2006; Haggstrom, Darling-Hammond, & Grissmer, 1988; Ingersoll, 2001; Kirby, Berends, & Naftel, 1999; Kirby & Grissmer, 1993). While retirement of teachers is an inevitable source of turnover, the loss of pre-retirement teachers continues to present an even greater challenge for U. S. schools (Ingersoll & Perda, 2009). Moreover, because discrepancies in the literature pertaining to the relationship between mobility patterns and common variables (e.g., gender, race, and subject area) exist, further exploration of these relationships is needed to develop a more comprehensive understanding about the current state of science teacher retention.

However, care must be taken when designing and implementing school policies. Continuous overhaul of policies and practices by school administrators results in teachers’ hesitation to accept new education philosophies and standards (Belfield, 2005; Day, 2008). For this reason, exploring the range and effectiveness of current retention strategies and challenges (environmental variables) and their interactions with teacher job satisfaction (cognitive variables) and teacher mobility (behavioral variables) become even more vital for assessing science teacher retention.

Rationale for Proposed Studies

Policy makers and science education stakeholders are confronted with the task of assessing *where are we* with respect to policies and strategies designed to retain science teachers. "The need for science teachers occurs at a time in educational history when opportunities for advancement, benefits, and working conditions appear more attractive in other science-related occupations" (Borman & Dowling as cited in Bozeman, 2010, p. 7; Weiss, 1999). Furthermore, increases in student enrollment and teacher retirement; higher standards for teacher certification; and a national focus expanding in the area of science, technology, engineering, and math (STEM) education also contribute to the need for improvement in science teacher retention (Bozeman, 2010; Carroll & Foster, 2010; Ingersoll, 2001; Stuessy, 2007; Texas Education Agency [TEA], 1995).

The three studies I proposed for this dissertation have allowed me to evaluate *where are we* with respect to retention of high school science teachers in Texas public schools. Specifically, the first study consisted of using descriptive statistical analyses to estimate mobility patterns and hiring patterns of high school science teachers after two academic years. I investigated these variables across 50 sample schools, as well as in the context of school size and minority student enrollment proportion (MSEP).

The second study used both regression analyses and descriptive statistical analyses to examine the relationships between school retention strategies and schools' science teacher retention rates. The nature and strength of these relationships allowed me to determine the extent of implementation and effectiveness of strategies designed to retain teachers. Evaluation of the relationships between school retention challenges and science teacher retention was also conducted in this study.

The final study for this dissertation used multilevel regression models to determine relationships among the following three variables: school retention strategies, science teacher job satisfaction, and science teacher mobility. Specifically, I explored the relationship between job satisfaction and science teacher mobility to determine if the result of this association would substantiate previous research. Interactions between retention strategies and job satisfaction were also explored to address deficiencies in the literature pertaining to how the relationships between these variables may serve as predictors of teacher mobility decisions.

Context of Proposed Studies

The three studies I proposed were done in conjunction with the Policy Research Initiative in Science Education (PRISE) research study which focused on the State-of-the-State of Texas high school science teacher professional continuum (TPC). "Conceptually, the high school science TPC refers to the professional lives of high school science teachers along the continuum of their recruitment, induction, renewal, and [retention] in the teaching profession" (Stuessy, Bozeman, Hollas, Richardson, Vasquez, Spikes, Yoo & Ivey, 2010, p. 7). The five-year PRISE research study sought to answer three essential policy research questions about the high school science TPC in Texas: *Where are we? Where do we want to go? How do we get there?*

I used mixed research methods “to query and analyze complex data sets of interviews, surveys, and archival data to investigate relationships between and among variables in the Texas high school science TPC” to determine *where are we* in terms of retention (Stuessy, 2010, p. 2).

CHAPTER II

RETENTION STRATEGIES, RETENTION CHALLENGES, TEACHER JOB SATISFACTION, AND TEACHER MOBILITY: A LITERATURE REVIEW

Reducing turnover of highly qualified science teachers is vital for gains in student science proficiency. High-profile reports produced by organizations such as the National Commission on Excellence in Education (NCEE, 1983) and the National Academy of Sciences (NAS, 2007) link teacher turnover to "the quality of education performance and, in turn, to the future well-being of the economy and the security of the nation" (Ingersoll & Perda, 2009, p. 2; Levy et al., 2006). Understanding and addressing complex issues like teacher turnover requires an extensive review of relevant empirical research. "[Stakeholders] cannot expect reform efforts in education to have significant effects without research-based knowledge to guide them" (National Research Council [NRC], 2002, p. 1).

As such, this literature review is designed to provide the reader with an appraisal of the research pertaining to the state of retention for science teachers in U. S. high schools. The first segment of this literature review, *Common Frameworks Exploring Teacher Mobility*, will provide a description of theoretical frameworks that researchers generally use to examine teacher mobility. Specifically, this segment will describe supply and demand and human capital theories. From this segment, I will move into the framework I have deemed most appropriate for my study, *reciprocal determinism*. The second segment of the review will provide a brief introduction of the triadic relationships involving environmental, behavioral, and cognitive variables proposed by Bandura (1977, 1978). Segments three, four, and five of the literature review will introduce the variables studied in this dissertation: *Retention Strategies and Retention Challenges, Teacher Job Satisfaction,* and *Trends and Costs of Teacher Mobility.* The final segment will highlight conclusions derived from the literature review specific to science teacher retention.

Common Frameworks Exploring Teacher Mobility

Supply and Demand

Supply and demand has been the framework of choice in multiple studies examining mobility in the teacher labor market (Guarino et al., 2006; Haggstrom et al., 1988; Hanushek et al., 2004; Ingersoll, 2006; Kirby et al., 1999). The supply of science teachers can be defined as the number of qualified individuals willing to teach science courses at a given wage (Borjas, 2005; Guarino et al., 2006). Most researchers characterize the supply of science teachers as predominantly White and female, with fewer teachers of color and men leading classrooms (Guarino et al., 2006; Hanushek et al., 2004; Kain et al., 2004; Kirby et al., 1999). The demand for science teachers has been defined as the number of science teaching positions offered at a given wage (Borjas, 2005; Guarino et al., 2006). “Texas, like many other states, is experiencing an increase in demand for high school science teachers” (Richardson, Troncoso-Skidmore, & Wilson, 2007, p. 1). For example, Fuller stated the demand for teachers has increased by 47 percent in Texas public schools from 1996 to 2002 (as cited in Richardson et al., 2007).

From a national perspective, the teacher labor market has shifted from a state of shortage in the 1950s, to surplus in the late 1960s to mid 80s, only to transition back into a state of shortage (Haggstrom et al., 1988; Herge, 1958; Kirby et al., 1999; Kirby & Grissmer, 1993; Loeb & Reininger, 2004). The increase in demand for teachers between the mid-1950s to late 1960s and late 1980s through 1990s may be attributed in part to the entry of baby boomers and the children of baby boomers into school, respectively (Loeb & Reininger, 2004). Periods of surplus typically correspond with a decrease in student-to-teacher ratios (Loeb & Reininger, 2004). These shifts between shortage and surplus states have been a common characteristic of the teacher labor market (Haggstrom et al., 1988).

According to the National Center for Education Statistics (NCES), "maintaining a sufficient supply of mathematics and science teachers depends on both entry rates into these teaching fields and out of these teaching fields" (2008, p. 1). Ingersoll's analysis of data in the *Schools and Staffing Survey* (SASS) for the 1999-2000 academic year revealed that roughly equal proportions of teachers enter and depart schools (Ingersoll, 2006). While approximately 535,000 teachers entered schools, approximately 546,000 departed schools by the end of the academic year (Ingersoll, 2006). Departures from teaching positions included teachers, who were classified as *movers* (those who migrate to teach at another school) and *leavers* (also known as attrition; refers to those who exit the teaching profession altogether; Ingersoll, 2001). Together, the numbers of these two departure groups were used to calculate teacher turnover. Though Ingersoll's (2001) findings suggested the supply and demand of most teachers across disciplines and grade levels were roughly the same, Ingersoll observed in that science teachers had the highest attrition rates (2006).

Consistent across studies were the spot shortages and uneven distribution of teachers in schools (Brill & McCartney, 2008; Herge, 1958; Ingersoll, 2001, 2006; Kain et al., 2004; Lankford et al., 2002). Coupled with increases in student enrollments and diversity, the uneven distribution of qualified teachers was also noted by Patterson (as cited in Richardson et al., 2007) as the major source fueling the teacher shortage in Texas. Economically disadvantaged schools, (i.e., schools where high proportions of students qualify for free or reduced lunch and other public assistance; Texas Education Agency [TEA], 2011), typically located in urban areas, experience more difficulty in supplying their schools with qualified science teachers in comparison to schools located within suburban and rural districts.[1] Hanushek, Kain, and Rivkin (2004) observed that Texas public school teachers preferred to teach in affluent schools with high performing student populations that were predominately White (Alliance for Excellent Education, 2008; Feng, 2005; Scafidi et al., 2007). Teacher sorting, also known as teacher segregation, leaves “low-income, low-achieving, and non-White students” (Lankford et al., 2002, p. 38) with the least experienced and least qualified teachers.

[1]Note: For more information about how the TEA classifies urban, suburban, and rural schools, please visit http://www.tea.state.tx.us/acctres/analyze/years.html.

Human Capital

Human capital theory has also been applied to analyze teacher mobility (e.g., Bempah et al., 1994; Grissmer & Kirby, 1987; Grissmer et al., 1992; Kirby & Grissmer, 1993; Rickman & Parker, 1990). Becker described human capital as "the activities that influence future monetary and psychic income increasing the resource in people" (as cited in Kilburn & Karoly, 2008, p. 6). These activities referred to the knowledge, skills, as well as personal characteristics an individual accumulates over the course of her lifetime (Kilburn & Karoly, 2008). The values of these activities are determined by the potential lifetime earnings of an individual (Borjas, 2005).

Grissmer and Kirby's use of human capital theory to examine attrition among Indiana teachers provided one of the most extensive applications of the model with respect to teacher mobility (e.g., Grissmer & Kirby, 1987; Grissmer et al., 1992; Kirby & Grissmer, 1993). Use of this model revealed two primary types of human capital teachers acquire: general and specific (Borjas, 2005; Grissmer & Kirby, 1987; Shen, 1997). General human capital refers to the generic education and training experiences teachers receive that are transferable to other professions (Grissmer & Kirby, 1987). The expense of these experiences is typically deducted from an employee's wage (Borjas, 2005). General experiences for teachers may include management, organizational, and presentation skills acquired from classroom experiences (Grissmer & Kirby, 1987).

The teacher certification process may also be viewed as a source of general human capital, particularly for science teachers. For instance, one basic prerequisite proposed by the Texas State Board of Educator Certification (SBEC) requires prospective teachers to obtain a bachelors' degree from an accredited four-year college or university in an academic major (Texas Education Agency [TEA], 2010b). Such guidelines were imposed to improve teacher quality. However, because science teachers typically possess a degree in their discipline areas, they also have the option of transferring these credentials to "other non-educational, potentially lucrative jobs" (Grissmer & Kirby, 1987, p. 13). The latter option may prove more appealing as science teachers weigh the costs (e.g., foregone earnings during years of schooling; accrued loan debt; and out-of-pocket expenses for books and tuition, also known as opportunity costs; Borjas, 2005) and benefits of remaining in the teaching profession (Bempah et al., 1994; Borjas, 2005).

Specific human capital refers to the education and training experiences that are specific to an occupation. Investments into human capital are usually made by both teachers and schools (Borjas, 2005). Because state school systems do not want to lose their investments, they reward teachers who remain in the profession with yearly-incremental wage increases. Other benefits, such as health insurance and retirement pensions, may also be provided to teachers (Grissmer & Kirby, 1987). This in turn decreases the likelihood of job separation, particularly among teachers who have already spent an extensive period in the profession. Fear of salary cuts and the inability to transfer specific human capital from a previous position to another can also deter teachers from leaving the profession. In addition, as experienced teachers have accumulated more specific training and are therefore considered more productive, schools are less likely to lay them off in comparison to novice teachers (Borjas, 2005).

Supply and demand theory and human capital theory provide simplistic models to examine science teacher mobility. However, a few important limitations of these models are noted. For instance, because both theories are wage-based, there is little emphasis on the interactions or influences of non-wage factors (e.g., other school environment factors) on teacher mobility. Cognitive and affective processes are also treated as secondary within each respective model. I believe that understanding the current state of science teacher retention extends beyond the wage-based theories utilized in labor economics. Based on this premise, I will use a model for this study that takes into account the additional role of cognitive factors and non-wage factors.

Reciprocal Determinism

Bandura (1978) proposed that "cognitive factors partly determine which external [factors] will be observed, how they will be perceived, whether they have any lasting effects, what valence and efficacy they have, and how the information they convey will be organized for future use" (p. 345). Social learning theory allows me to analyze cognitive factors in the context of reciprocal determinism. Reciprocal determinism is a model that centers on the triadic interaction between cognitive, behavioral, and environmental factors, which act as determinants of each other (Bandura, 1977, 1978; see Figure 2.1). "In this triadic reciprocal determinism…*reciprocal* is defined as the mutual action between [factors, whereas] *determinism* signifies the production of effects by factors" (Bandura, 1983, p. 166).

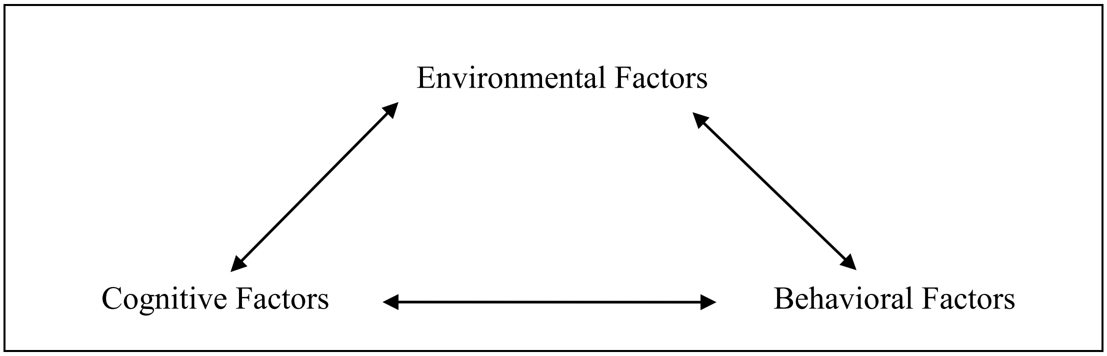

Figure 2.1 Schematic adaption depicting triadic relationship between environmental, cognitive, and behavioral factors as suggested in reciprocal determinism. Adapted from "The Self System in Reciprocal Determinism," by A. Bandura, 1977, *American Psychologist, 33*(4), p. 345.

Alternative models that take into account cognitive, behavioral, and environmental factors typically relegate behavior as a by-product of cognitive and environmental forces (Bandura, 1978). These alternate models suggest either (a) environmental and cognitive determinants are separate entities that combine to produce behavior, or (b) while interaction between environmental and cognitive influences is bidirectional, "it retains a unidirectional view on behavior" (Bandura, 1978, p. 345). By contrast, reciprocal determinism views these factors (i.e., cognitive, behavioral, and environmental) as interlocking entities that stimulate, respond, and reinforce one another (Bandura, 1978). Researchers who use reciprocal determinism as a theoretical framework acknowledge the role an individual's behavior has in creating one's environment or altering cognitive and affective processes (Bandura, 1978). I chose to use the reciprocal determinism framework for my dissertation studies.

The primary variables I investigated for this literature review included those associated with the retention of high school science teachers: retention strategies, retention challenges, science teacher job satisfaction, and science teacher mobility. The overall purpose of my study was to examine the current state of high school science teacher retention in Texas public schools. Table 2.1 provides a list of studies that support my research. Because the reciprocal determinism framework is based on the triadic relationship between environmental, cognitive, and behavioral forces, I chose literature in which each factor was addressed in appraised studies. However, because Bandura (1978) acknowledged that the major dominance of each variable varies under different circumstances, the table also differentiates between primary and secondary foci within each study. I also included the analytic method used by each study's author(s) to illustrate the common analysis methods currently used in this field of research.

Table 2.1
Research articles that focus on the primary variables of this dissertation study

Article		**Framework Focus[1]**			**Analysis Method**
Title	**Authors(s) (Year)**	**E**	**C**	**B**	
Teacher attrition and retention: A meta-analytic narrative review of the research	Borman and Dowling (2008)	■	□	■	Odds ratio
Finding, supporting, and keeping: The role of the principal in teacher retention issues	Brown and Wynn (2009)	■	□	□	Constant comparative analysis
Do school accountability systems make it more difficult for low-performing schools to attract and retain high-quality teachers?	Clotfelter, Ladd, Vigdor, and Diaz (2004)	□	□	■	Descriptive statistics; Random-effect logit regression

Note.[1] The focus of each article is classified as environment (E), cognition (C), and behavior factors (B).
[2] ■ Primary focus of article. □ Secondary focus of article.

Table 2.1 Continued

Article		Framework Focus[1]			
Title	**Author(s) (Years)**	**E**	**B**	**C**	**Analysis Method**
Why public schools lose teachers	Hanushek, Kain, and Rivkin (2004)	■	□	■	Descriptive statistics; Quartile distribution; Regression
Teacher turnover and teacher shortages: An organizational analysis	Ingersoll (2001)	■	□	■	Descriptive statistics; Multiple regression; Qualitative
Leavers, movers, and stayers: The role of workplace conditions in teacher mobility decisions	Kukla-Acevedo (2009)	■	□	■	Linear probabiltiy; Competing risks
Finding their way on: Career decision-making processes of urban science teachers	Rinke (2009)	□	■	□	Within-case analysis and cross-case analysis
Race, poverty, and teacher mobility	Scalfidi, Sjoquist, and Stinebrickner (2007)	■	□	■	Descriptive statistics; Linear probability; Competing risks

Note.[1] The focus of each article is classified as environment (E), cognition (C), and behavior factors (B).
[2]■ Primary focus of article. □ Secondary focus of article.

Figure 2.2 shows how I perceive the variables for this study fitting into Bandura's reciprocal determinism framework. Supporting evidence from the literature will be used to clarify the dynamics of these variables in subsequent sections. However, because reciprocal determinism has suggested variables within this relationship may act as either stimulus, response, or a reinforcing consequent depending on where one begins to analyze these interactions (Bandura, 1978), the reader will note overlaps as interactions emerge throughout this literature review.

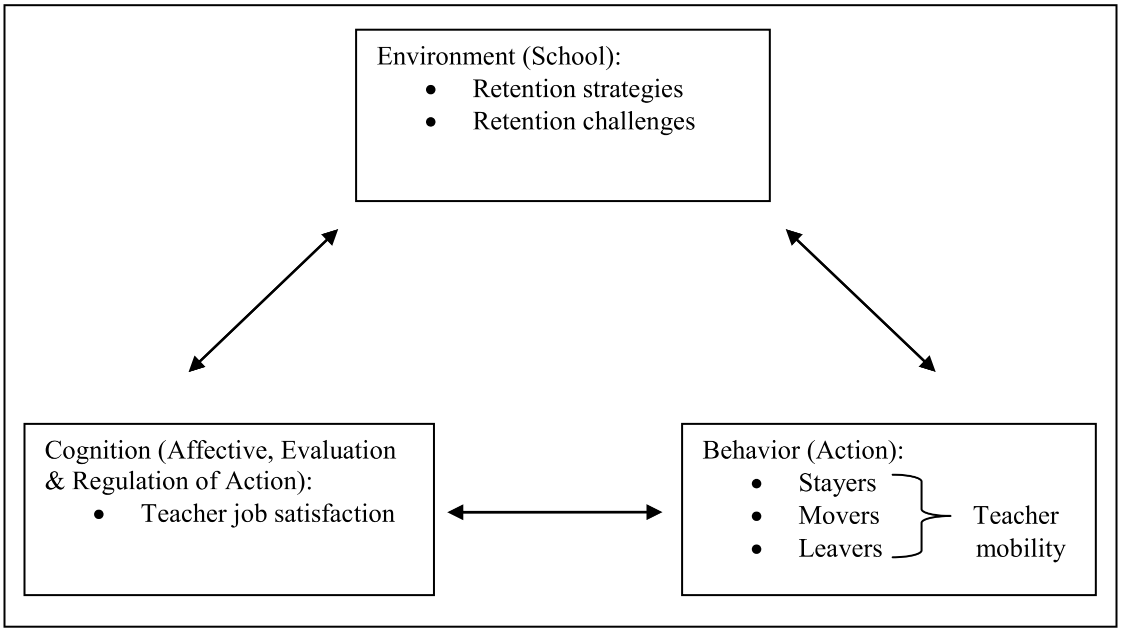

Figure 2.2 Conceptual map for literature review adapted from the reciprocal determinism theory. Adapted from "The Self System in Reciprocal Determinism," by A. Bandura, 1977, *American Psychologist, 33*(4), p. 345.

Environmental Factors: Retention Strategies and Retention Challenges

Administrative decisions, policy implementation, and finances can dictate whether current policies encompassing these factors either improve or pose a challenge to science teacher retention. For this section, I will elaborate on specific school factors related to teacher retention. A review of the literature has identified administrative support and leadership, salary, student demographics, and working conditions as factors associated with teacher satisfaction and mobility within a school environment (e.g., see Borman & Dowling, 2008; Brown & Wynn, 2009; CAE, 2004; Hanushek et al., 2004; Ingersoll, 2000, 2001, 2006; Kain et al., 2004; Kirby & Grissmer, 1993; Stevenson, Dantley, & Holcomb, 1999).

Administrative Support and Leadership

The conclusion that schools with strong administrative support and leadership have more success in retaining teachers is widely reported in the literature (e.g., Bempah et al., 1994; Borman & Dowling, 2008; Brown & Wynn, 2009; CAE, 2004; Ingersoll, 2001; Weiss, 1999). Borman and Dowling's (2008) meta-analysis of retention studies identified regular and supportive administrators as moderators for teacher retention and departures. Charlotte Advocates for Education (CAE) noted effective principals have qualities of successful entrepreneurs; emanating visionary, self-motivating problem-solving characteristics (2004). Principals in the CAE study identified the following strategies as leading to their success in retaining teachers: demonstrating strong leadership skills, building relationships with staff, providing professional growth, supporting teachers, and including teachers in decision-making processes (2004).

School administrators are challenged to meet the needs of novice teachers by providing adequate support and induction experiences. In Brown and Wynn's (2009) study, both principals and novice teachers agreed that providing support and shared leadership in decision-making processes played a role in teacher retention. Ivey and Stuessy (2009) concurred that strong administrative support is particularly important for novice teachers who "are often in survival mode during their first years of teaching as they struggle to develop classroom routines, teaching style, curriculum, and expertise" (p. 6). The authors proposed that practices supporting novice science teachers' development should involve the active participation of principals and experienced science teachers (Ivey & Stuessy, 2009). Specifically, these practices should: (a) create a professional community that invites new science teachers, (b) offer multiple resources and renewal opportunities for new science teachers to gain new knowledge, (c) personalize support for novice science teachers as learners, and (d) provide multiple venues for feedback and assessment (Ivey & Stuessy, 2009). Experienced teachers may also benefit from such support to persevere through the daily intellectual, physical, and psychological demands required of them in their classrooms (Block, 2008). Optimization of the school learning environment for science teachers will allow novice teachers to develop into experts, allow experienced teachers to refine their practices, improve student achievement, and increase science teacher retention.

Salary

Metty and Ivey's (2007) review of the literature suggested the improvement of high school science teacher retention may require providing "competitive salaries, additional stipends, and other monetary rewards" (p. 2). Many states and districts provide financial incentives such as performance pay plans and incentive plans to improve teacher recruitment and retention (Herbert & Ramsay, 2004; Kirby & Grissmer, 1993). Table 2.2 is an adaptation and summary of Kirby and Grissmer's (1993) assessments of three specific incentive plans: (1) differential pay, (2) performance pay, and (3) career ladder pay. A description of the single salary schedule plan is also included.

Most U. S. teachers' pay is based on a single salary schedule that takes into account years of experience and number of university credits and degree earned (Consortium for Policy Research in Education [CPRE], 2007). These pay schedules are "often set by state officials, local school boards, unions, and citizens" (Brown, Gonzalez, Reyes, & Alexander, 2010, p. 3). Because these plans are typically standardized, single salary schedules fail to accommodate for differences in the needs and contexts unique to schools (Brown et al., 2010). Kirby and Grissmer (1993) contended the inflexibility of single salary schedules facilitates the persistent shortages in specialty areas such as science.

Differential pay, on the other hand, may focus on the following: (a) attracting and retaining teachers new to the district, (b) targeting teachers who teach high needs subject areas, or (c) targeting teachers who teach in high poverty and/or rural districts (Herbert & Ramsay, 2004; Kirby & Grissmer, 1993). The expense of differential pay varies depending on the type of school district. Because pay differentials are historically based on gender and racial differences, some opponents of differential incentives consider the current use of such policies as resurrecting discriminatory practices (Kirby & Grissmer, 1993). Inequitable distribution of funds has also been an argument used by opponents, such as teacher unions, to discourage use of differential incentives (Kirby & Grissmer, 1993; refer to Table 2.2).

Table 2.2
Incentive plans used in conjunction with single salary schedules

Salary Program	**Target Population**	**Primary Action**	**Advantages**	**Disadvantages**
Single Salary Schedule (SSS)	General teacher population	Uniform salary distribution	*None specified in study	Facilitates persistent shortage
Differential Pay (DP)	New teachers	Increase salaries for teachers within a specialty	Simple	Expensive (i.e., salary increase); opposition by teacher unions; historical discrimination
		One-time bonus; higher initial pay step; higher pay offered to select new hires	*None specified in study	
Performance (Merit) Pay (PP)	General teacher population	Identify outstanding teachers; link salary schedule to performance (yearly bonuses)	Requires candidates to demonstrate behavior of "good" teaching practices	No universal set of teaching practices; unreliable evaluation procedures; inadequate funds; administrative concerns
Career Ladder Pay (CLP)	General teacher population	Identify professionally committed teachers; awarded extra pay for extra work	Leave emphasis on evaluation, more on teacher responsibilities (easier to measure)	Difficult to evaluate teachers; lack of evidence for positive outcomes of CLP; lack of teacher input

Note. Categorical review of plans adapted from *Teacher attrition: Theory, evidence, and suggested policy options*. S.N. Kirby & D.W. Grissmer, 1993. RAND [unedited], Santa Monica, California, 1-49.

Performance pay (also called merit pay) "is directed to all teachers, and is based on some measure of teaching performance, usually evaluations, student achievement (e.g., on state-mandated exams), or a combination of the two" (Herbert & Ramsay, 2004, p. 6). Examples of performance-based compensation systems in Texas under current evaluation include the Governor's Educator Excellence Grant, the Texas Educator Excellence Grant, and Teacher Initiative Funds. These programs seek to not only improve student achievement, but to also recruit and retain highly qualified teachers in shortage subject areas and economically disadvantaged schools (Brown et al., 2010; Moran, 2007). The problem with basing these financial incentives on performance ratings or demographics is that the latter variables are subject to change over time, causing school administrators and policy makers to re-direct funding in some cases year by year (Herbert & Ramsay, 2004; Kirby & Grissmer, 1993). While career ladder pay is more feasible in measuring teacher responsibilities for award consideration (Stoko, Ingram, & Beaty-O'Ferral, 2007), evaluating teachers is still quite difficult to accomplish (Kirby & Grissmer, 1993).

Recently, more challenges have emerged further compromising the feasibility for compensation incentive reform. For instance, a study conducted by Kain, Rivkin, and Hanushek (2004) showed female teachers were less responsive to salary increases once their decisions have been made to leave a school. As classrooms are primarily led by women, this phenomenon presents a challenge for financial initiatives put forward to alleviate staffing shortages by subject area and school context (i.e., schools with highly disadvantaged, low-achieving, ethnic minority student populations). The authors pointed out that while incentives such as *combat pay*, bonuses, and increases in salary may alleviate turnover, implementation of such policies can become extremely costly (Hanushek et al., 2004; Kain et al., 2004).

Student Demographics

Consistent across studies are the spot shortages and uneven distribution of science teachers in schools (Herge, 1958; Ingersoll, 2001, 2006; Kain et al., 2004). A mitigating factor associated with this occurrence is teacher sorting. Research studies suggest that teachers prefer to not take positions within disadvantaged schools (Lankford et al., 2002; Scafidi et al., 2007). Disadvantaged schools typically have high populations of students of color and low student academic performance (Clotfelter, Ladd, Vigdor, & Diaz, 2004; Hanushek et al., 2004; Lankford et al., 2002; Scafidi et al., 2007). As disadvantaged schools are typically located in urban areas, urban school districts are often faced with the challenge of higher turnover (Rinke, 2009).

The ramifications of teacher sorting have suggested an education system that is "separate and unequal" (U.S. Department of Education [ED], 2003, p. 4). The Coleman Report examination of equal educational opportunities in the mid-1960s found that teacher quality did not show a statistically significant correlation to student achievement. However, the report did concede that differences in teacher quality have a negative cumulative effect on the achievement of disadvantaged, students of color (Wong & Nicotera, 2004). This is an important consideration, particularly for Texas, as this state is one of five that receives the highest influx of immigrants, thereby impacting diversity in student enrollments (Camarota, 2005). Current initiatives, such as loan forgiveness programs and increased salaries, used to increase teacher retention in disadvantaged schools have produced mediocre results (Lankford et al., 2002). Effective policy alternatives are still needed in this particular area.

Working Conditions

Working conditions (e.g., student discipline problems, facility conditions, and autonomy) can influence teachers' morale, career choice commitment, and retention (Hanushek et al., 2004; Harcombe, Knight, & Bellamy, 1992; Hidalgo, 2004; Kukla-Acevedo, 2009; Metty & Ivey, 2007; Metty & Stuessy, 2007; Weiss, 1999). For example, student misbehavior has been identified as a source of dissatisfaction for teachers within the work environment (Belfield, 2005; Klassen & Anderson, 2009). While reform efforts such as "respect bills" and bills "giving schools and teachers more disciplinary powers" (Belfield, 2005, p. 186) were intended to counter student misbehavior, these efforts have been met with opposition (Belfield, 2005). For instance, the respect bills put forward by states in the 1990s "were challenged by parents (whose rearing competence was being questioned), by teachers (who sought more authority to discipline students), and by those who objected to such clumsy social engineering" (Belfield, 2005, p. 186). Such barriers to reform have led to either rejected or watered-down policies, with little improvement in the working conditions of schools (Belfield, 2005).

Providing working conditions that allow teachers to refine their practices and confront misconceptions may contribute to teacher retention and development (Harcombe et al., 1992). Harcombe, Knight, and Bellamy (1992) observed that increases in the effectiveness and retention of science instructors were impacted by providing "time in a safe work environment in which to network with other teachers, and to learn new ways of teaching that focus on what students understand" (p.143). Schools that provide a safe, nurturing learning environment usually have higher teacher retention rates (Metty & Ivey, 2007).

Provision of well-equipped science laboratories and adequate classroom space influences teacher retention, teacher instruction, and student learning. Five features identified by Metty and Stuessy (2007), as supporting the learning goals for high school science, include: (1) well designed science classrooms supplied with adequate resources; (2) science laboratories that provide adequate space, equipment, and science materials; (3) technologies supporting real-world science experiences; (4) providing real-world learning environments outside the classroom that integrate and extend science conceptual knowledge and process; and (5) provision of an adequate school budget. In contrast, poor working conditions hinder Texas science educators from fulfilling state requirements such as the 40% laboratory rule (refer to Texas Education Agency [TEA], 2010a), thereby compromising instruction.

Laboratory activities may also provide the additional strain of out-of-pocket expenses when department budgets are insufficient. Because teaching assignments and classroom selection in some schools are dictated by seniority, induction-year science teachers have the increased likelihood of receiving the least favorable teaching assignments and "floating" between classrooms. The cumulative effect of these variables may become too cumbersome for these science educators, leading them to consider other employment options (Weiss, 1999).

Research findings have suggested that schools encouraging teacher autonomy have higher retention (Kukla-Acevedo, 2009; Metty & Ivey, 2007; Weiss, 1999).

Principals who support teacher autonomy encourage a school culture of professionalism, leadership, and collegiality (Weiss, 1999). “When administrators interfere with instructional practices and instructional time, they leave teachers feeling powerless to effectively teach; as a result some teachers choose to leave the profession” (Harcombe et al., 1992; Hong as cited by Metty & Ivey, 2007, p. 3). Weiss (1999) observed teacher autonomy, along with school leadership and school culture, was associated with induction-year teachers’ intentions to stay in teaching. Although Kukla-Acevedo’s (2009) findings showed that classroom autonomy had no statistical significance on the transitional decisions for teachers, the study indicated a positive relationship between teacher autonomy and teacher retention.

The literature is exhausted with studies that examine the relationship between environmental factors (i.e., administrative support, salary, working conditions, and student characteristics) and teacher mobility outcomes. However, results from these studies have been typically based on prediction and probability analyses. Because of this, it remains unclear (a) if these factors are utilized as specific strategies for teacher retention, (b) the extent to which these strategies are applied at the school-level, and (c) if variants of each strategy are better suited to specific school contexts (Knapp, 2003). In addition, the relative strength between these variables and teacher retention provides only superficial insight into the challenges school administrators experience in retaining science teachers. Exploration of these uncertainties was a primary focus of this dissertation.

Cognitive Factors: Teacher Job Satisfaction

Several studies have suggested that a positive association exists between teacher job satisfaction and teacher retention (Eick, 2002; Ingersoll, 2000, 2001, 2006; Stockard & Lehman, 2004; Stuessy, 2007). While review of the literature does not provide a universal definition for job satisfaction (e.g., Bozeman & Stuessy, 2009; Butt & Lance, 2005; Eick, 2002; Ingersoll, 2000, 2001, 2006; Locke, 1969; Scott, Gravelle, Simoens, Bojke, & Sibbald, 2006; Stevenson et al., 1999; Stockard & Lehman, 2004; Vandenberg & Lance, 1992), variables commonly used in these studies include demographic, background, parental involvement, and administrative support (Stockard & Lehman, 2004). One can reason that satisfaction levels are a result of cognitive and affective processes (Huitt & Cain, 2005). Job satisfaction, therefore, can be used to represent the construct of cognitive factors in this dissertation. The remainder of this section will focus on research pertaining to teachers' job satisfaction and perceptions about their school appointments.

Characterizing Job Satisfaction

An individual's consciousness has three basic biological functions: (1) cognition, (2) evaluation, and (3) regulation of action (Locke, 1969). These functions are an important dynamic within the reciprocal determinism framework. As a person discovers what her life requires (cognition), she goes through a process of acquiring implicit and explicit value standards (Locke, 1969). These value standards allow an individual to evaluate whether or not an object, action, or condition will augment or threaten her values (Locke, 1969). Emotions serve as value-responses of a rapid, subconscious evaluation (Locke, 1969). “Job satisfaction and dissatisfaction are then [characterized] as complex, emotional reactions to the job” (Locke, 1969, p. 314). The emotional state distinguishing these two variables is “a function of the perceived relationship between what one wants from one's job and what one perceives it as offering or entailing” (Locke, 1969, p. 316).

Satisfaction

Figure 2.3 is an illustration of common teacher job satisfaction variables that were identified as I reviewed the literature. Figure 2.3 highlights common variables within a school that teachers typically observe and reflect upon as they consider their level of satisfaction. The cognitive and affective processes (Huitt & Cain, 2005) teachers undergo as they consider their circumstance is an important component of reciprocal determinism. Categorization of identified variables was based on how each was perceived in their respective studies. Based on their subjectivity in quality and school context, some variables were sorted into the moderator category. Because each main category contained school-level variables, i.e., collegial staff, poor wages, administrative support, overlap may have existed (see Figure 2.3).

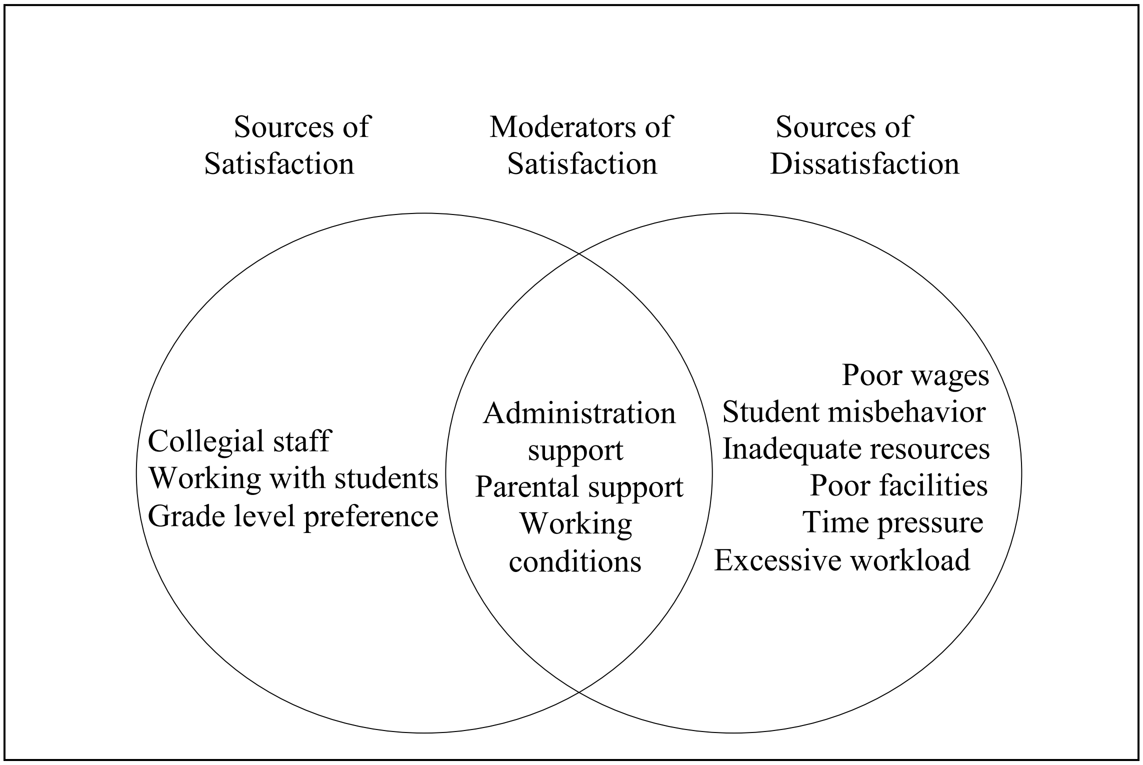

Figure 2.3 Factors identified as (a) sources of satisfaction, (b) moderators of satisfaction, and (c) sources of dissatisfaction in the literature.

Sources of Satisfaction

Primary sources of teacher job satisfaction have included working in a collegial and supportive environment, working with students, and teaching at a preferred grade level (Hean & Garrett, 2001; Huang & Fraser, 2009; Watson, 2006). Hean and Garrett's (2001) investigation observed that secondary science teachers derived much of their satisfaction from relationships with other teachers and students. Interestingly, this study also noted that as teachers aged, they became less satisfied with student relationships and more satisfied with taking on the role of student developer (Hean & Garrett, 2001). With respect to the role of developer, similar findings were noted among science education majors who became teachers compared to their science major counterparts (Eick, 2002).

Sources of Dissatisfaction

Major factors identified as sources of job dissatisfaction among teachers were poor wages, student misbehavior, inadequate resources, poor facilities, time pressure, and excessive workload (see Figure 2.3; Bozeman & Stuessy, 2009; Butt & Lance, 2005; Hongying, 2007; Huang & Fraser, 2009; Ingersoll, 2001; Klassen & Anderson, 2009; Skaalvik & Skaalvik, 2009; Watson, 2006). Time pressure and excessive workload were each widely designated as sources of dissatisfaction among teachers (Butt & Lance, 2005; Hean & Garrett, 2001; Huang & Fraser, 2009; Klassen & Anderson, 2009; Skaalvik & Skaalvik; 2009). Specific time and work constraints included excessive workload of non-teaching tasks; covering classes for absent teachers, resulting in the loss of non-contact hours; burden of time-consuming government initiatives; and lack of planning time (Butt & Lance, 2005). Reference to poor resources and facilities were particularly noted in studies investigating science teachers (Bozeman & Stuessy, 2009; Hongying, 2007; Watson, 2006). For instance, the PRISE Research Group found that Texas high school science teachers had low levels of satisfaction with science lab facilities and science equipment at their schools (Bozeman & Stuessy, 2009). Because science teachers' satisfaction levels fell below 60.0%, Texas high schools received a grade of "F" for this particular aspect of the work environment (Bozeman & Stuessy, 2009). Although not identified specifically as a source of dissatisfaction, Hongying's review of the literature also indicated the conditions of facilities may have moderated science teacher satisfaction (2007).

Moderators of Satisfaction

Administrative support, parental support, and working conditions in general were identified as moderating factors of job satisfaction in multiple studies (e.g., Duffy & Lent, 2009; Skaalvik & Skaalvik, 2009; Stockard & Lehman, 2004). In addition, these moderating variables were also noted to be associated with teacher retention (see Borman & Dowling, 2008; Brown & Wynn, 2009; CAE, 2004; Harcombe et al., 1992; Hidalgo, 2004; Ingersoll, 2001; Kukla-Acevedo, 2009; Metty & Ivey, 2007; Metty & Stuessy, 2007; Weiss, 1999).

Dissonance

Appraisals of research findings have indicated variations in dissonance between teachers' perceptions and administrators' perceptions about conditions within the workplace. For instance, Colley's (2003) observation of an urban school district in the state of New York revealed school-level administrators' views about school practices were more aligned with secondary science teachers' views, in contrast to district-level administrators. While school administrators had a tendency to focus on teachers' personal and professional needs, district administrators were more inclined to take a bureaucratic, impersonal approach (Colley, 2003). In addition, summary findings from a study of North Carolina schools revealed that principals had a more positive perception about working conditions than teachers (Southeast Center for Teaching Quality [SCETQ], 2004). Failure by administrators to recognize, acknowledge, and incorporate critical concerns identified by teachers into policy statutes may have impeded increases in satisfaction levels, as well as student achievement and teacher retention outcomes (SECTQ, 2004).

Examining teachers' satisfaction and perceptions is vital for policy reform. Bozeman and Stuessy (2009) expressed that such knowledge "can allow policymakers to (a) develop strategies for increasing teachers' levels of satisfaction with their working environments in order to increase teacher retention; and (b) make predictions regarding the likeliness of sustaining a workforce of highly qualified science teachers" (p. 1). A review of the literature makes it clear the school environment factors that are associated with job satisfaction are also likely to be associated with teacher mobility. Furthermore, teacher job satisfaction within the school environment has been noted to be an important moderator between teacher mobility and teacher professional activity (Bozeman, 2010). However, because dissonance exists between administrators' perceptions and teachers' satisfaction about the quality of school practices, the congruency and relationship between schools' practices and teachers' job satisfaction warrants further investigation. Examining this association within the reciprocal determinism framework was a primary focus of this dissertation.

Behavioral Factors: Trends and Costs of Teacher Mobility

Literature cited in the previous sections (i.e., *Retention Strategies and Retention Challenges* and *Teacher Job Satisfaction*) has provided insight into the environmental and cognitive forces taking place within schools that are associated with teacher mobility. The introduction of terms such as *mobility, sorting,* and *segregation* are behaviors science education stakeholders should consider when examining teachers' response(s) to a school setting. In this section, I will provide a summary of mobility patterns and probabilities within the teacher workforce, shifting focus to what this evidence may imply about the cost of teacher mobility to schools.

Mobility Trends by Age

As a function of both age and experience, teacher turnover has had a U-shaped pattern, with the highest turnover rates occurring among young teachers in their first few years of teaching and experienced teachers approaching retirement (Darling-Hammond, 2000; Grissmer et al., 1992; Guarino et al., 2006; Haggstrom et al., 1988; Ingersoll, 2001; Kirby et al., 1999; Kirby & Grissmer, 1993). Though some studies have suggested teacher mobility reaches its lowest point between ages 40-49 years (Grissmer et al., 1992; Kirby & Grissmer, 1993; Texas Education Agency [TEA], 1995), a report by the Texas Education Agency (TEA) found teacher mobility in Texas reached its lowest point for ages 60-64 (1995). This may be attributed in part to specific rules (e.g., Rule of 80) of the Teacher Retirement System (TRS) of Texas, where retirement benefits are based on a combination of years of service and age.[2]

Mobility Trends by Experience

High turnover in the first three to five years of teaching has been cited in many studies (Carver & Feiman-Nemser, 2008; Guarino et al., 2006; Haggstrom et al., 1988;

[2]Note: For more information about the rules of the Teacher Retirement System (TRS), please refer to http://www.trs.state.tx.us/benefits/documents/benefits_handbook.pdf#Home.

Ingersoll, 2001; Kirby et al., 1999). According to the 2008-2009 Teacher Follow-up Survey, 22.8% of public school teachers with one to three years of experience either migrated to another school or left the profession (National Center for Education Statistics [NCES], 2010). This mobility rate is slightly higher than findings reported in previous studies (see Hanushek et al., 2004; TEA, 1995).

Numerous variables are associated with novice teacher attrition. Haggstrom, Darling-Hammond, and Grissmer (1988) suggested that novice teacher departures from a teaching position may be an indication of mismatches between original expectations and actual experiences. Novice teachers' expectations typically stem from previous experiences in a well-managed classroom during their years of schooling (Feiman-Nemser, 2001) and student teaching experiences. However, when charged with leading their own classrooms novice science teachers reported feeling less prepared for practical classroom experiences and for teaching diverse audiences (Watson, 2006). As staff members with the least seniority, novice teachers were also more likely than experienced teachers "to be impacted by a reduction in force, declining enrollments, or school district organizational changes" (Elfers et al., 2006, p. 107; Ingersoll, 2001). As a result, teachers may exhibit behaviors that consist of (a) involuntary dismissal, (b) resigning from a position, (c) presenting grievances to school administrators, or (d) accepting the regime and remaining at a school (Townsend, 1990).

Inconsistencies in mobility patterns have occurred particularly among *movers* within the profession. For instance, national-level data has suggested teachers with fewer than four years of experience were more likely to move to another public school district than remain in the same district (NCES, 2010). Similar findings were noted in a study by Kukla-Acevedo examining workplace conditions and teacher mobility decisions (2009). However, results from a five-year longitudinal study conducted by Elfers, Plecki, and Knapp (2006) on teacher mobility in the state of Washington observed that teachers, regardless of years of experience, were more likely to migrate within the same district as opposed to switching districts. With respect to *leavers* from the profession, an increase in movement out of the profession occurred as teachers with many years of experience approached retirement (Hanushek et al., 2004).

Mobility Trends by Gender

Appraisal of the literature has also revealed discrepancies in mobility specific to gender. For instance, some studies have proposed an attrition gap, with female teachers having higher attrition rates than male teachers (Borman & Dowling, 2008; Grissmer et al., 1992; Guarino et al., 2006; Ingersoll, 2001). While an investigation by the TEA (1995) reported comparable findings of teachers in their first five years of teaching, this investigation also reported higher attrition rates occur among first-year male teachers. Additionally, because women who exit the teaching profession are more likely to return as opposed to men, the attrition rate gap has narrowed between the two genders (Grissmer et al., 1992). Outcomes from the 2008-2009 Teacher Follow-up Survey (TFS), however, have showed no gender differences in *stayers*, *movers*, and *leavers* (NCES, 2010), further highlighting discrepancies in studies that have examined gender mobility trends.

Mobility Trends by Race and Ethnicity

Evaluation of retention and mobility studies has suggested both racial and ethnic minority teachers have lower attrition rates than their White and Caucasian counterparts (Borman & Dowling, 2008; Guarino et al., 2006; Ingersoll, 2001; Kirby et al., 1999; Scalfidi et al., 2007). The role of race and ethnicity in teacher mobility has been commonly highlighted in studies that have investigated the relationships between teacher turnover and student characteristics (e.g., Hanushek et al., 2004; Kain et al., 2004; Lankford et al., 2002; Scalfidi et. al. 2007). For example, Scalfidi, Sjoquist, and Stinebrickner's (2007) study on public elementary school teachers has suggested that Black teachers were less likely to leave predominantly Black schools than White teachers. Similar findings in an earlier study conducted by Hanushek et al. (2004) suggest that higher rates of Black student enrollments into a school increased the probability that White teachers exit a school. In contrast, increases in percent Black student enrollments "tend to reduce rather than increase the probability of transitions for Black teachers" (Hanushek et al., 2004, p. 350). However, national-level data showed that racial and ethnic minority teachers (i.e., Black teachers and Asian teachers) had lower retention rates compared to teachers identified as either White or of Hispanic origin (NCES, 2010). Other findings suggest that no significant differences have existed between the retention of White and Non-White teachers (Elfers et al., 2006).

Mobility Trends by Subject

Because science is a core subject in both elementary and secondary public schools, understanding evidence focused on science teacher mobility trends is important (NCES, 2008). Ingersoll's (2001) organizational analysis suggested that science teachers were just as likely as teachers of other disciplines to depart the profession. This conclusion was supported by an earlier report on Texas school teachers that showed science teachers have similar turnover patterns compared to teachers in other disciplines across the state (TEA, 1995). Conversely, another study conducted by Ingersoll observed that science teachers had the highest attrition rates compared to other subject areas (2006). This latter observation was also supported by an earlier study conducted by Grissmer, Kirby, Schlegel, and Young (1992) who posited science teachers have both higher annual and permanent attrition from the teaching profession than teachers of other subjects. Lack of success for science teacher retention is also noted in a recent investigation conducted by the PRISE Research Group of 50 sampled Texas high schools. This research group found that approximately one-quarter of the science teachers in their representative sample was lost in one year (Stuessy, Bozeman, & Ivey, 2009).

Policy Impact on Mobility

Implementation of new policies or enforcement of current policies may induce changes in teacher mobility patterns (Brown et al., 2010; Clotfelter et al., 2004; Lewis & London, 2009). An investigation by Clotfelter, Ladd, Vidgor, and Diaz (2004) showed that the ABCs accountability system implemented in North Carolina increased teacher turnover in low-performing schools. The authors suggested that increasing accountability standards on the personnel in low-performing schools may not have been the best way to improve student achievement (Clotfelter et al., 2004). Conversely, Lewis and London's (2009) case study revealed that enforcement of accountability policies resulted in improvements in hiring practices, professional learning community practices, teacher effectiveness, and student learning. Teachers perceived as "uncommitted to or incapable of meeting [district] expectations" (p. 29) were replaced with teachers who better fit into the new school culture (Lewis & London, 2009). This managed short-term turnover tactic was perceived to render long-term retention outcomes (Lewis & London, 2009). While the latter study is less generalizable, both studies suggested that reform efforts have varying effects based on school circumstances and policies.

Costs of Mobility

The overall cost of teacher mobility varies. For instance, teacher mobility places a financial burden on school systems. Seeking, hiring, and training new teachers to replace those who have departed is an expensive and time consuming process (Boe, Bobbitt, Cook, Whitener, & Weber, 1997; Brill & McCartney, 2008; Feng, 2005; Kukla-Acevedo, 2009). Kirby and Grissmer (1993) estimated that 70.0% of new teachers are hired every year to replace teachers who have either migrated within or departed from the profession. The remaining "30.0% [of new teachers] are hired to meet the needs of expanding student enrollments, smaller classes, and new programs" (Kirby & Grissmer, 1993, p. 3). "In Texas, the cost of [mobility] per lost teacher, based on the salary of first-year teachers, is estimated to be between $6,060 and $48,480" (Texas Center for

Educational Research [TCER], as cited in Feng, 2005, p. 2). Based on estimations determined by the U. S. Department of Labor, teacher mobility costs Texas approximately $504,000,000 a year (Alliance for Excellent Education [AEE], 2005).

Non-pecuniary expenses of mobility are just as costly. For instance, "high teacher [mobility] affects the school community and hinders long term planning" (Brill & McCartney, 2008, p. 752). School performance and a sense of community between families, teachers, and students are the most important indicators of successful schools (Ingersoll, 2001). High levels of teacher mobility at a school may indicate an organizational problem and disrupt the cohesion and environment of the school community (Brill & McCartney, 2008; Ingersoll, 2001, 2006). In addition, constant change in staff impedes the development of a coherent, comprehensive, uniform curriculum (Brill & McCartney, 2008).

Teacher turnover disproportionately affects low income, high ethnic minority, low-achieving students (Brill & McCartney, 2008; Hanushek et al., 2004; Herge, 1958; Ingersoll, 2001, 2006). When science teachers leave their positions, they take their pedagogical practices, classroom management skills, and knowledge about their students' learning abilities with them. High-minority, impoverished schools typically have higher proportions of new teachers leading the classrooms. New teachers that enter these schools "without the content knowledge or skills needed to teach all students" (Kahle & Kronebusch, 2003) "often do not understand how their expectations and 'deficit assumptions,' which view cultural differences as deficiencies, influence their teaching practices" (Song & Christiansen as cited in Kahle & Kronebusch, 2003, p.

590). These beliefs may also strain relationships between White teachers and teachers of color. This increases the pressure experienced by school administrators to not only provide support for new teachers, but also push these teachers to meet state accountability achievement standards with ill-prepared students. Natriello, McDill, and Pallas comment that the inability to alleviate turnover of expert science teachers in high-need areas will result in the “failure to educate the educationally disadvantaged, [which] may have catastrophic consequences for the social and economic well-being of this country” (as cited by Kirby et al., 1999, p. 47).

Conclusion

Despite national and state level efforts to improve retention of expert science teachers, detrimental turnover persists. Persistence of this phenomenon suggests new avenues are needed to examine teacher retention and turnover. Bandura’s model of reciprocal determinism is a theoretical framework that provides a fresh perspective on science teacher retention. Using the school as a unit of analysis, this model allows for the examination of variations in the reciprocal interactions between the school environment as defined by reported retention strategies and experienced retention challenges, mobility patterns of science teachers, and science teachers’ reflections on personal job satisfaction. Investigating the reciprocal dynamics between these variables can provide insight into the social organization of a school’s professional climate. Reciprocal determinism provides a useful theoretical framework to examine the current state of retention for high school science teachers.

Teacher mobility is a multi-faceted phenomenon. As such, disagreement is commonplace when developing ideas about ways to approach the problem of teacher mobility. Dissonance exists between school administrators' perceptions and teachers' perceptions about the effectiveness of school practices, which widen at the district level (Colley, 2003). While it is important to consider reasons provided by teachers for turnover, expansion of research in the areas of policies, and practices dictated by district and school level administrators is just as important. With this in mind, care must be taken when designing and implementing school policies. Continuous overhaul of policies and practices results in teachers' hesitation to accept new education philosophies and standards (Belfield, 2005; Day, 2008). For this reason, exploring the quality and types of retention practices currently in place becomes even more vital.

So far, persisting deficiencies in published works have limited science education stakeholders' abilities to develop policies specific to retention. Results from studies that examine relationships between the school environment and retention outcomes provide little insight into how these variables may differ for specific school contexts (e.g., Borman & Dowling, 2008; Hanushek, et al., 2004; Kain et al., 2004; Kukla-Acevedo, 2009). Furthermore, few studies follow up on actual measurements of mobility outcomes (see e.g., Clotfelter et al., 2004; Hanushek et al., 2004; Scafidi et al., 2007). Although organizations such as the NCES open databases for public use, few investigators focus primarily on science education. Because of these shortcomings, it is still quite difficult to assess *where are we* in regards to high school science teacher retention. More comprehensive and representative studies on teacher mobility are needed so that policymakers can make informed decisions regarding teacher retention. Thus, the intent of my study will be to gather empirical evidence of variables related to science teacher retention that contribute to alleviating the aforementioned literature deficiency.

CHAPTER III

ESTIMATED MOBILITY PATTERNS AND HIRING PATTERNS OF HIGH SCHOOL SCIENCE TEACHERS

Years of national and state level reform efforts to improve science education have not changed the conclusion that most Americans lack science proficiency (e.g., AAAS, 1990, p. xv). Findings of the National Assessment of Educational Progress (NAEP) confirm that approximately four out of five high school graduates do not achieve proficient levels in science (National Center of Education Statistics [NCES], 2011). Furthermore, the typical ethnic minority student does not even meet the basic competency levels that denote “partial mastery of the knowledge and skills that are fundamental for proficient work [in science]” (NCES, 2011, p. 6). Inadequacies in students’ knowledge of science implicate other facets within the United States public education system may also be experiencing relatable problems. One such facet is the turnover of highly qualified science teachers. A recent review of the literature suggests turnover of highly qualified science teachers has a negative impact on students’ science achievement (Levy et al., 2006).

Concerns over the turnover of highly qualified teachers “have pervaded policy discussions for decades” (see AEE, 2008; Boe et al., 1997; Feng, 2005; Hanushek et al., p. 326; Ingersoll, 2000). Schools serving predominantly low-income, high-minority, low-achieving students are particularly vulnerable to turnover (e.g., Brill & McCartney, 2008; Hanushek et al., 2004; Herge, 1958; Ingersoll, 2001, 2006). For example, research suggests teachers departing from these schools are more likely to be replaced by less qualified teachers in contrast to affluent, low-minority, high-achieving schools (Boyd, Lankford, Loeb, Rockoff, & Wyckoff, 2008; Lankford, Loeb, & Wyckoff, 2002). Low-quality instruction is linked to the achievement gap associated with socioeconomic and racial differences in this country (e.g., Clotfelter et al., 2004). Understanding science teachers' movements into and outside of the teaching profession will be valuable to sustaining both a high-quality science teacher workforce and high-quality science instruction for all K-12 students. As such, this chapter examines mobility and hiring patterns of public high school science teachers.

Related Literature

"Teacher mobility is the inclusive term for outcomes associated with teacher employment, including retention, migration, and attrition" (Bozeman, 2010, p. 3). The term retention refers to individuals who remain at a school. Conversely, departures from schools include teachers who are classified as *movers* (those who migrate to teach at another school) and *leavers* (also known as attrition; refers to those who exit the teaching profession altogether; Ingersoll, 2001). Together, the numbers of these two departure groups are used to calculate teacher turnover.

So far, mobility studies of science teachers have provided policy analysts and education stakeholders information about the demographic composition and behavior, i.e., movement and distribution, of the teacher workforce. The composition of the teacher workforce may be characterized as predominantly White and female, with few teachers of color and men leading classrooms (Guarino et al., 2006; Hanushek et al., 2004; Kain et al., 2004; Kirby et al., 1999). Attempts to link teacher demographics, as well as subject area focus, to mobility patterns have led to mixed results in previous research (e.g., Elfers et al., 2006; Grissmer et al., 1992; Ingersoll, 2001; Ingersoll & Perda, 2009; NCES, 2010; TEA, 1995). However, consistent across mobility studies was the U-shaped pattern that indicated high turnover rates occurred among young teachers in their first few years of teaching and for older teachers after many years in the profession (Darling-Hammond, 2000; Grissmer et al., 1992; Guarino et al., 2006; Haggstrom et al., 1988; Ingersoll, 2001; Kirby et al., 1999; Kirby & Grissmer, 1993). Teachers who migrate from one school to another typically move to schools with higher percentages of high achieving, White, affluent students (Borman & Dowling, 2008). This findings was linked to evidence that suggested uneven distributions of high-quality teachers with respect to student demographics (i.e., minority profile, socioeconomic status, and academic achievement; AEE, 2008; Feng, 2005; Lankford et al., 2002; Richardson et al., 2007; Scafidi et al., 2007).

Costs of Turnover: Pecuniary and Non-Pecuniary Expenses

Seeking, hiring, and training new teachers to replace those who have departed is an expensive and time consuming process (Boe et al., 1997; Brill & McCartney, 2008; Feng, 2005; Kukla-Acevedo, 2009). Kirby and Grissmer (1993) estimated that 70.0% of new teachers replace individuals who have either migrated within or departed from the teaching profession. The remaining "30.0% are required to meet the needs of expanding enrollments, smaller classes, and new programs" (Kirby & Grissmer, 1993, p. 3). "In Texas the cost of [mobility] per lost teacher based on the salary of first-year teachers [is] estimated to be between $6,060 and $48,480" (TCER, as cited in Feng, 2005, p. 2). Based on estimations determined by the U.S. Department of Labor, teacher mobility costs Texas approximately $504,000,000 a year (AEE, 2005). In addition, these costs place limitations on funding for other areas in K-12 education. Such areas include instructional and professional development support for in-service teachers, and materials, technologies, and extracurricular activities used to enhance science learning environments (Brill & McCartney, 2008).

Non-pecuniary expenses of turnover are just as costly. For instance, "high teacher [turnover] affects the school community and hinders long term planning" (Brill & McCartney, 2008, p. 752). School performance and a sense of community among administrators, teachers, and students are important indicators of successful schools (Ingersoll, 2001). High levels of teacher turnover at a school may indicate an organizational problem and disrupt the cohesion and environment of the school community (Brill & McCartney, 2008; Ingersoll, 2001, 2006). Additionally, continuous turnover of teachers impedes the development of a coherent, comprehensive, uniform curriculum (Brill & McCartney, 2008).

Policy Impact on Mobility

Implementation of new policies or enforcement of current policies may induce changes in teacher mobility patterns (Brown et al., 2010; Clotfelter et al., 2004; Lewis & London, 2009). For example, an investigation conducted by Clotfelter et al. (2004) observed that the ABCs system implemented in North Carolina to increase accountability among teachers for student achievement resulted in increased teacher turnover in low-performing schools. Conversely, Lewis and London's (2009) case study revealed that while enforcement of accountability policies resulted in short-term turnover, long-term improvements occurred in both hiring and professional learning community practices, student learning, teacher effectiveness, and teacher retention. While the Lewis and London study was less generalizable, both studies suggested that policy reform efforts may have varying effects based on school culture. Therefore, care must be taken by both district- and school-level administrators when introducing new education policies (Belfield, 2005; Day, 2008).

Purpose of This Study

Few studies focus on exploring high school science teacher mobility or "the complex relationships that exist among a number of school-related and teacher-related factors" (Stuessy et al., 2009, p. 1). In addition, it remains unclear as to who is hired to replace departing teachers (Levy et al., 2006). In an effort to address these deficiencies in evidence, this study examined mobility and hiring patterns of public high school science teachers. Specifically, this study provides evidence to address the following research questions:

Research Question 1: What are the mobility patterns of high school science teachers in Texas public high schools?

Research Question 2: What are the hiring patterns of high school science teachers in Texas public high schools?

Mobility patterns and hiring patterns for high school science teachers were examined across 50 sample schools, as well as in the context of school size and minority student enrollment proportion (MSEP). Patterns were examined between the 2007-2010 school years.

Context of Study

This investigation was conducted in conjunction with the Policy Research Initiative in Science Education (PRISE) research project at Texas A&M University, College Station. This five-year, state-level research project studied four critical school areas: recruitment, induction, professional development, and retention (Stuessy, 2009; Stuessy et al., 2010). These areas are related to both the alleviation of high school science teacher turnover and the improvement of students' science achievement (Stuessy et al., 2010).

For this study, I took a pragmatic, mixed methods approach to "query and analyze …archival data to investigate relationships between and among variables in the Texas high school science teacher professional continuum (TPC)" that deal with the movement of teachers in and out of sample schools (Stuessy, 2010, p. 2). The term *school* refers to (a) the Texas public school where high school science is taught, and (b) administrator or district policies and strategies that are implemented at the school level. Qualitative and quantitative research strategies were used to triangulate both state- and school-level data sources in order to identify science teachers and their respective demographics. I also used descriptive statistical analyses to deduce mobility and hiring patterns of high school science teacher demographics with respect to school context.

Methods

Sampling Plan

A two-phase, stratified random sampling plan described by McNamara and Bozeman (2007) was used to identify a sample of schools and teachers. Fifty sample schools were identified in the *first phase* of the plan. Two explicit stratification variables were used simultaneously to create the representative school sample: (1) a three-level classification variable indicating the size of student enrollment (i.e., Small, Medium, and Large), and (2) a four-level classification variable indicating the minority student enrollment proportion (i.e., Very Low, Low, High, and Very High). Stratifications were based on the University Interscholastic League (U.I.L.) classification system in Texas and student demographic percentages, respectively.[3] A third implicit variable, geographic region, was also used to yield results that were representative of the 1,333 Texas public schools that offer high school science courses. The "[Statistical Package for the Social Sciences] (SPSS) software was used to identify, select, and verify schools within the sample. Validity of the sample was verified by chi-square [analysis] to assure the sample was indeed representative of the entire population of schools in Texas" (Stuessy, 2009, p. 3).

[3]Note: A central purpose of the University Interscholastic League (U.I.L.) in Texas is to organize and properly supervise educational activities guided by rules of good sportsmanship and fair play for all participants. To ensure equitable competition on a state-wide basis, UIL member schools compete with other schools of comparable size (www.uiltexas.org).

Of the original 50 schools selected, researchers achieved an overall random participation rate of 78.0% (n =39). Modification of the sampling plan allowed for the selection of replacement schools. Involvement of the replacement schools yielded a 100.0% participation rate of sample schools (Bozeman & Stuessy, 2009, p. 3).

The *second phase* of the sampling plan identified teachers employed at the sample schools that taught at least one high school science course. Random selection of teachers was not conducted. Participants from each of the selected schools included principals (n = 50, 100.0%), science teacher liaisons (n = 50, 100.0%), and high school science teachers (n = 385, 89.2%). Subjects were asked for their written consent to participate in the PRISE project. Liaisons and science teachers received a small stipend for their involvement.

Data Collection

High School Science Teachers. School master schedules and teacher lists were collected from the 50 sample schools in school years 2007-2008, 2008-2009, and 2009-2010 by PRISE researchers. These data sources were used to identify sample teachers who taught high school science courses in sample schools. To ensure confidentiality, codes were assigned to each science teacher. In addition, Texas Education Agency (TEA) databases were queried to obtain information about sample teachers' course assignments, demographics, and characteristics (e.g., gender, ethnicity, date of birth, and total years of teaching experience). These data were collected, coded, and archived in the PRISE Teacher Database.

Data Analysis

Descriptive statistical analyses were used to determine frequency counts and percentages of mobility and hiring patterns for high school science teachers in 50 sample schools. A teacher's mobility status was determined by identifying a teacher's name in relation to a sample school. Specifically, the 385 science teachers identified in 2007-2008 were tracked across two academic years to determine if they stayed, moved, or left from their respective schools. Teachers that were classified as *movers* either (a) remained at a school, but taught a non-science course; (b) moved to teach at another school within the same district, or (c) moved to teach at another school outside the district. Once a science teacher left her respective sample school no further tracking occurred to distinguish if she continued to teach high school science. The names of science teachers classified as *leavers* were not identified in either school- or state-level archived datasets for academic years 2008-2009 or 2009-2010. These teachers were assumed to have left the profession.

With respect to hiring patterns, 147 science teachers new to a sample school were identified by first determining if they taught at least one high school science course, and second, by cross checking with data from previous years to ensure these teachers were not already teaching at respective sample schools. Frequency counts and percentages of science teachers were calculated for both 2008-2009 and 2009-2010 school years. Cross tabs analyses were used to calculate frequency counts and percentages for mobility and hiring patterns of high school science teacher demographics by school size and MSEP. Demographic variables included age which was determined by subtracting a teacher's year of birth (Y.O.B) from year of entry into the PRISE Teacher Database. Ethnicity and gender were both categorical variables as classified by the TEA database. Teacher type was also a categorical variable based on science teachers' total years of experience. Specifically, teachers were categorized as either Novice teachers (i.e., teachers with 0-2 years of experience), Mid-Career teachers (i.e., teachers with 3-6 years of experience), and Veteran teachers (i.e., teachers with seven or more years of experience). Years of teaching experience were not limited to science education.

Results

Mobility Status for High School Science Teachers

Mobility Patterns. Table 3.1 displays the mobility status of high school science teachers in sample schools from the 2007-2008 school year. Results from Table 3.1 reveal that schools lost approximately one-quarter (24.7%, n = 95) of their science teachers after one year. This proportion increased to approximately one-third the following school year (35.9%, n = 138). Comparisons between mobility statistics for academic years 2008-2009 and 2009-2010, however, did indicate a reduction in teacher turnover. Results also show teachers that exited a sample school were just as likely to be classified as either *mover* or a *leaver*.

Table 3.1
Mobility status of 385 high school science teachers in PRISE sample schools after two school years

	Mobility Status					
	Stayer		Mover		Leaver	
School Year	Frequency Count	(%)	Frequency Count	(%)	Frequency Count	(%)
2008-2009	290	75.3	47	12.2	48	12.5
2009-2010	247	64.1	65	16.9	73	19.0

Table 3.2 shows mobility patterns with respect to high school science teachers' demographics. Results reveal retention rates were highest among Veteran science teachers (69.8%) compared to both Mid-Career and Novice science teachers (60.6% and 53.9%, respectively). While migration rates were highest among Mid-Career teachers (23.0%), attrition rates were highest among Novice teachers (26.5%) compared to respective teacher types within sample schools.

Regarding age, retention rates were highest among science teachers between the ages of 40-49 years (73.3%) compared to other age groups. Migration rates were highest among teachers between the ages of 20-29 years. Attrition rates were high among both science teachers between the ages of 20-29 years (27.3%) and teachers 60 years and older (30.3%).

With respect to gender, results reveal that female science teachers had higher retention rates (66.5%) in contrast to male science teachers (61.4%). These relationships

Table 3.2

Mobility status of 385 high school science teacher demographics in PRISE sample schools after two school years

Teacher Demographics	n	Mobility Status: Stayer Frequency Count	Stayer (%)	Mover Frequency Count	Mover (%)	Leaver Frequency Count	Leaver (%)
Teacher Type							
Novice	102	55	53.9	20	19.6	27	26.5
Mid-Career	61	37	60.6	14	23.0	10	16.4
Veteran	222	155	69.8	31	14.0	36	16.2
Age							
20-29 years	77	39	50.6	17	22.1	21	27.3
30-39 years	104	66	63.5	18	17.3	20	19.2
40-49 years	90	66	73.3	14	15.6	10	11.1
50-59 years	81	56	69.1	13	16.0	12	14.8
$\geq$ 60 years	33	20	60.6	3	9.1	10	30.3
Gender							
Female	206	137	66.5	22	10.7	47	22.8
Male	179	110	61.4	43	24.0	26	14.5
Ethnicity							
African American	18	12	66.6	3	16.6	3	16.6
Asian	7	4	57.1	2	28.6	1	14.3
Hispanic	72	49	68.0	10	13.8	13	18.0
White	288	182	63.2	50	17.4	56	19.4

Note. Frequency counts and percentages were based on proportions of respective teacher demographics.

were more pronounced with respect to teacher attrition. Migration rates for male teachers, on the other hand, were over two times higher than that of female teachers.

Table 3.2 also shows mobility patterns of teachers by ethnic identity. Results indicate that across all 50 sample schools Hispanic and African American science teachers had higher retention rates (68.0% and 66.6%, respectively) compared to White science teachers (63.2%). However, because 288 of the 385 science teachers (74.8%) were classified as White, comparisons of migration and attrition patterns between ethnic groups was limited. As a consequence of sample size limitations, comparisons of mobility patterns between ethnic groups were not conducted based on school size and minority student enrollment proportion (MSEP).

Mobility Patterns by School Size. Tables 3.3 and 3.4 show mobility status of high school science teachers after two years based on school size. Results from Table 3.3 show that Large-sized schools had the highest retention rates (67.4%) for science teachers compared to both Small-sized and Medium-sized schools (62.0% and 55.4%, respectively). Migration rates, similar for both Small-sized and Medium-sized schools, were lowest for Large-sized schools. Attrition rates reveal similar patterns for Medium-sized and Large-sized schools, both higher than Small-sized schools. Overall, Medium-sized schools experienced the highest science teacher turnover (44.6%).

Table 3.3
Mobility status of 385 high school science teachers in PRISE sample schools after two school years by school size

		Mobility Status					
		Stayer		Mover		Leaver	
School Size	n	Frequency Count	(%)	Frequency Count	(%)	Frequency Count	(%)
Small	29	18	62.0	7	24.1	4	13.8
Medium	92	51	55.4	23	25.0	18	19.6
Large	264	178	67.4	35	13.2	51	19.3

Table 3.4 shows high retention rates for both Novice (71.4%) and Mid-Career science teachers (75.4%) in Small-sized schools. Retention rates were highest among Mid-Career and Veteran science teachers at Medium-sized schools, whereas Large-sized schools had the most success in retaining Veteran teachers (73.6%). Migration rates also differed for each school size. Migration patterns revealed (a) Veteran teachers moved from Small-sized schools, (b) Novice teachers from Medium-sized schools, and (c) Mid-Career teachers from Large-sized schools at higher rates compared to other teacher types. Results show that attrition rates were highest among Novice science teachers leaving both Small-sized and Large-sized schools. Conversely, Medium-sized schools lost higher percentages of Mid-Career teachers to attrition.

Regarding mobility patterns with respect to age demographics, retention rates for Small-sized schools were highest among science teachers between the ages of 20-29 years (83.0%). Both Medium-sized and Large-sized schools experienced highest retention rates among teachers between the ages of 40-49 years, with the addition of science teachers ages 50-59 years retained in Large-sized schools. Comparisons of migration patterns between school sizes reveal teachers between 50-59 years left Small-sized schools at higher rates (42.8%) compared to Medium-sized and Large-sized schools. Medium-sized schools experienced highest migration among teachers 60 years and older, while Large-sized schools experienced highest migration among teachers between the ages of 20-29 years. Similar across all school contexts were high attrition rates among teachers 60 years and older. High attrition rates were likewise noted among teachers between 30-39 years (26.6%) and teachers between 20-29 years (31.4%) from Medium-sized and Large-sized sample schools, respectively.

Comparisons of mobility patterns between female science teachers and male science teachers revealed similar trends in the context of Small, Medium, and Large schools. Retention rates were higher among female teachers in Small-sized and Medium-sized schools in contrast to male teachers. Large-sized schools, however, retained roughly equal percentages of female teachers (67.1%) and male teachers (67.8%) after two academic years. Both migration rates and attrition rates of female and male teachers were similar in Medium-sized and Large-sized schools. Results show that while male teachers migrated at higher rates than female teachers in the profession, female teachers left teaching at a higher rate from these schools. Though migration patterns based on gender occurring in Small-sized schools were similar to other schools sizes, attrition revealed male teachers left the profession at higher rates in contrast to female teachers.

Table 3.4

Mobility status of 385 high school science teacher demographics in PRISE sample schools after two school years by school size

	Mobility Status by School Size																				
	Small-sized schools							Medium-sized schools							Large-sized schools						
		Stayer		Mover		Leaver			Stayer		Mover		Leaver			Stayer		Mover		Leaver	
Teacher Demographics	n	F	%	F	%	F	%	n	F	%	F	%	F	%	n	F	%	F	%	F	%
Teacher Type																					
Novice	7	5	71.4	0	0.0	2	28.6	36	16	44.4	14	38.9	6	16.6	59	34	57.6	6	10.2	19	32.2
Mid-Career	8	6	75.0	2	25.0	0	0.0	11	7	63.6	1	9.1	3	27.3	42	24	57.1	11	26.2	7	16.6
Veteran	14	7	50.0	5	35.7	2	14.3	45	28	62.2	8	17.8	9	20.0	163	120	73.6	18	11.0	25	15.3
Age																					
20-29 years	6	5	83.3	0	0.0	1	3.4	20	8	40.0	8	40.0	4	20.0	51	26	51.0	9	17.6	16	31.4
30-39 years	4	2	50.0	1	25.0	1	25.0	30	16	53.3	6	20.0	8	26.6	70	48	68.6	11	15.7	11	15.7
40-49 years	8	5	62.5	3	37.5	0	0.0	21	16	76.2	3	14.3	2	9.5	61	45	73.8	8	13.1	8	13.1
50-59 years	7	4	57.1	3	42.8	0	0.0	17	10	58.8	4	23.5	3	17.6	57	42	73.7	6	10.5	9	15.8
$\geq$ 60 years	4	2	50.0	0	0.0	2	50.0	4	1	25.0	2	50.0	1	25.0	25	17	68.0	1	4.0	7	28.0
Gender																					
Female	14	10	71.4	3	21.4	1	7.4	43	27	62.8	6	14.0	10	23.2	149	100	67.1	13	8.7	36	24.2
Male	15	8	53.5	4	26.6	3	20.0	49	24	49.0	17	34.7	8	16.3	115	78	67.8	22	19.1	15	13.0

Note. F = Frequency counts of high school science teachers. Frequency counts and percentages were based on proportions of respective teacher demographics.

Mobility Patterns by Minority Student Enrollment Proportion (MSEP). Tables 3.5 and 3.6 present mobility status of high school science teachers after two years based on their schools' minority student enrollment proportion (MSEP). Results from Table 3.5 show that retention rates of science teachers at Very Low MSEP, High MSEP, and Very High MSEP schools were similar. Low MSEP sample schools, however, experienced the highest turnover losing approximately half (51.0%, n = 25) of their science teachers. Comparisons between *movers* and *leavers* of different schools show that Low MSEP schools experienced both the highest migration and attrition rates in contrast to other MSEP schools.

Table 3.5
Mobility status of 385 high school science teachers in PRISE sample schools after two school years by minority student enrollment proportion

School Minority Student Enrollment Proportion	n	Mobility Status					
		Stayer		Mover		Leaver	
		Frequency Count	(%)	Frequency Count	(%)	Frequency Count	(%)
Very Low	136	89	65.4	24	17.6	23	16.9
Low	49	24	49.0	11	22.4	14	28.6
High	68	46	67.6	12	17.6	10	14.7
Very High	132	88	66.7	18	13.6	26	19.7

Table 3.6 compares mobility status of science teacher demographics after two years based on MSEP. Results reveal high retention rates for Veteran science teachers in both Very Low and Very High MSEP sample schools. Mid-Career science teachers were more likely to be retained in Low MSEP schools in contrast to other teacher types. Migration rates show higher percentages of Mid-Career teachers in contrast to both Novice and Veteran teachers moved from either Low MSEP or Very High MSEP schools. Veteran teachers were also noted to move at higher rates from Low MSEP schools. Novice science teachers, on the other hand, migrated at higher rates from Very Low and High MSEP schools. Regarding attrition rates, descriptive statistics revealed Novice teachers left at higher rates from Low, High, and Very High MSEP schools. Veteran teachers also exited High MSEP schools at similar rates. Attrition was highest among Mid-Career teachers leaving Very Low MSEP schools.

With respect to age, high retention rates for science teachers between 40-49 years occurred in both Very Low MSEP and Very High MSEP schools (80.0% and 78.6%), respectively). Very High MSEP schools also had more success in retaining teachers 60 years and older (77.7%). Both Low and High MSEP schools, on the other hand, had high retention rates for teachers between 50-59 years (61.5% and 100.0%, respectively).

More variation was observed with respect to migration and attrition patterns based on age. Migration patterns revealed science teachers between the ages of 20-29 years moved at higher rates from Very Low, High, and Very High MSEP schools. Both Very Low and Very High MSEP schools also experienced high migration from teachers between 50-59 years, whereas High MSEP schools also experienced high migration from teachers 60 years and older. Science teachers between the ages of 30-39 years moved at higher rates from Low MSEP schools. Results for attrition patterns reveal (a) teachers between 20-29 years left both Very Low MESP and Very High MSEP schools, (b) teachers 60 years and older left Low MSEP schools, and (c) teachers between 30-49 years left High MSEP schools at higher rates compared to respective age groups and MSEP contexts.

With respect to mobility of high school science teachers based on gender, patterns tended to be consistent regardless of school MSEP. Migration rates were high among male science teachers compared to female science teachers. Attrition rates were typically higher among female teachers. The only exception in gender patterns was retention rates that occurred in Very High MSEP schools. While higher percentages of female teachers were retained in other school contexts in contrast to male teachers, Very High MSEP schools had higher success at retaining male science teachers.

Table 3.6

Mobility status of 385 high school science teacher demographics in PRISE sample schools after two schools years by Minority student enrollment proportion

	Mobility Status by Minority Student Enrollment Proportion													
	Very Low MSEP schools							Low MSEP Schools						
		Stayer		Mover		Leaver			Stayer		Mover		Leaver	
Teacher Demographics	n	F	%	F	%	F	%	n	F	%	F	%	F	%
Teacher Type														
Novice	30	16	53.3	8	26.6	6	20.0	11	5	45.4	2	18.2	4	36.4
Mid-Career	26	14	53.8	6	23.1	6	23.1	4	3	75.0	1	25.0	0	0.0
Veteran	80	59	73.8	10	12.5	11	13.8	34	16	47.0	8	23.5	10	29.4
Age														
20-29 years	28	13	46.4	6	21.4	9	32.1	8	4	50.0	2	25.0	2	25.0
30-39 years	34	22	64.7	6	17.6	6	17.6	12	6	50.0	4	33.3	2	16.6
40-49 years	35	28	80.0	6	17.1	1	2.8	10	5	50.0	3	30.0	2	20.0
50-59 years	28	18	64.3	6	21.4	4	14.3	13	8	61.5	2	15.4	3	23.1
$\geq$ 60 years	11	8	72.7	0	0.0	3	27.3	6	1	16.6	0	0.0	5	83.3
Gender														
Female	73	50	68.5	9	12.3	14	19.2	25	14	56.0	2	8.0	9	36.0
Male	63	39	61.9	15	23.8	9	14.3	24	10	41.6	9	37.5	5	20.8

Note. F = Frequency counts of high school science teachers. Frequency counts and percentages were based on proportions of respective teacher demographics.

Table 3.6 continued

	Mobility Status by Minority Student Enrollment Proportion													
	High MSEP schools							Very High MSEP schools						
		Stayer		Mover		Leaver			Stayer		Mover		Leaver	
Teacher Demographics	n	F	%	F	%	F	%	n	F	%	F	%	F	%
Teacher Type														
Novice	20	12	60.0	5	25.0	3	15.0	41	22	53.6	5	12.2	14	34.1
Mid-Career	10	8	80.0	1	10.0	1	10.0	21	12	57.1	6	28.6	3	14.3
Veteran	38	26	68.4	6	15.8	6	15.8	70	54	77.1	7	10.0	9	12.8
Age														
20-29 years	16	10	62.5	5	31.2	1	6.2	25	12	48.0	4	16.0	9	36.0
30-39 years	18	11	61.1	3	16.6	4	22.2	40	27	67.5	5	12.5	8	20.0
40-49 years	17	11	64.7	2	11.8	4	23.5	28	22	78.6	3	10.7	3	10.7
50-59 years	10	10	100.0	0	0.0	0	0.0	30	20	66.7	5	16.6	5	16.6
≥ 60 years	7	4	57.1	2	28.6	1	14.3	9	7	77.7	1	11.1	1	11.1
Gender														
Female	40	29	72.5	4	10.0	7	17.5	68	44	64.7	7	10.3	17	25.0
Male	28	17	60.7	8	28.6	3	10.7	64	44	68.8	11	17.2	9	14.1

Note. F = Frequency counts of high school science teachers. Frequency counts and percentages were based on proportions of respective teacher demographics.

Hiring Patterns for High School Science Teachers

Tables 3.7 and 3.8 report hiring patterns of high school science teachers for school years 2008-2009 and 2009-2010 across all 50 sample schools. According to Table 3.7, the number of science teachers hired over a span of two years (n = 147) was slightly higher than the number of turnovers experienced by schools reported previously in Table 3.1 (n = 138). Results also indicate that the majority of new hires occurred in the 2008-2009 school year (n = 81, 55.1%). The demographic composition of new science teachers hired into Texas schools may be characterized as predominantly Novice teachers between the ages of 20-39 years identified as White and female (Table 3.8). Because approximately 70.0% of the teacher population hired by Texas schools was identified as White, comparisons of hiring patterns based on ethnicity were not conducted by school size and MSEP.

Table 3.7
Numbers of new hires in PRISE sample schools after two school years

School Year	Frequency Count
2008-2009	81
2009-2010	147

Table 3.8
Hiring patterns of 147 high school science teacher demographics in PRISE sample schools after two school years

New Hire Demographics	Frequency Count	Percentage (%)
Teacher Type		
Novice	87	59.2
Mid-Career	23	15.6
Veteran	37	25.2
Age		
20-29 years	50	34.0
30-39 years	47	22.0
40-49 years	24	16.3
50-59 years	24	16.3
≥ 60 years	2	1.4
Gender		
Female	85	57.8
Male	62	42.2
Ethnicity		
African American	13	8.8
Asian	5	3.4
Hispanic	24	16.3
Native American	1	0.7
White	104	70.7

Table 3.9 compares hiring patterns of high school science teacher demographics by school size after the 2008-2009 and 2009-2010 school years. Results indicate that regardless of school size, higher percentages of Novice science teachers were hired into Texas schools in contrast to both Mid-Career and Veteran science teachers. Regarding age, Small-sized schools had higher percentages of new science teachers between the ages of 30-39 years compared to other age groups. Both Medium-sized and Large-sized schools, however, typically hired teachers who were in the 20-29 year age range. Differences in hiring patterns were also noted based on gender. While higher

percentages of female science teachers filled vacancies at both Small-sized and Large-sized schools, male science teachers were more likely to be hired into Medium-sized schools.

Table 3.9
Hiring patterns of 147 high school science teacher demogrpahics in PRISE sample schools after two school years by school size

		Hiring Patterns by School Size					
		Small-sized schools		Medium-sized schools		Large-sized schools	
Teacher Demographics	n	Frequency Count	(%)	Frequency Count	(%)	Frequency Count	(%)
All Teachers	147	7	4.8	41	27.9	99	67.3
Teacher Type							
Novice	87	3	42.9	29	70.7	55	55.6
Mid-Career	23	2	28.6	3	7.3	18	18.2
Veteran	37	2	28.6	9	22.0	26	26.3
Age							
20-29 years	50	2	28.6	17	41.4	39	39.4
30-39 years	47	3	42.8	9	22.0	30	30.3
40-49 years	24	0	0.0	8	19.5	13	13.1
50-59 years	24	2	28.6	7	17.1	15	15.2
$\geq$ 60 years	2	0	0.0	0	0.0	2	2.0
Gender							
Female	85	6	85.7	19	46.3	60	60.6
Male	62	1	14.3	22	53.7	39	39.4

Table 3.10 compares hiring patterns of high school science teacher demographics by minority student enrollment proportion (MSEP) after two years. Results indicate that regardless of MSEP, schools typically hired Novice, female teachers in contrast to respect demographics. Both Very Low MSEP and High MSEP sample schools hired

Table 3.10
Hiring patterns of 147 high school science teacher demographics in PRISE sample schools after two school years by minority student enrollment proportion

		Hiring patterns by Minority Student Enrollment Proportion							
		Very Low MSEP schools		Low MSEP schools		High MSEP schools		Very High MSEP schools	
Teacher Demographics	n	Frequency Count	(%)	Frequency Count	(%)	Frequency Count	(%)	Frequency Count	(%)
All Teachers	147	39	26.5	23	15.6	30	20.4	55	37.4
Teacher Type									
Novice	87	20	51.3	11	47.8	20	66.7	36	65.6
Mid-Career	23	5	12.8	5	21.7	3	10.0	10	18.2
Veteran	37	14	35.9	7	30.4	7	23.3	9	16.4
Age									
20-29 years	50	15	38.5	5	21.7	14	46.6	16	29.1
30-39 years	47	11	28.2	9	39.1	7	23.3	20	36.4
40-49 years	24	9	23.1	3	13.0	3	10.0	9	16.4
50-59 years	24	4	10.2	5	21.7	6	20.0	9	16.4
$\geq$ 60 years	2	0	0.0	1	4.3	0	0.0	1	1.8
Gender									
Female	85	21	53.8	15	65.2	18	60.0	31	56.4
Male	62	18	46.2	8	34.8	12	40.0	24	43.6

greater percentages of science teachers between the ages of 20-29 years compared to other age groups. In contrast, both Low MESP and Very High MSEP schools hired greater percentages of teachers that were between 30-39 years of age.

Table 3.11 displays a summary of the numbers of *stayers*, *movers*, *leavers*, and new hires in relation to school context. Results based on school size indicate that Small-sized schools only replaced 63.6% of their science teachers by the 2009-2010 school year. The number of science teachers hired into Medium-sized schools was equivalent to the number of teachers lost to turnover over the course of two years (n = 41). Large-sized schools, however, hired a surplus of teachers by the 2009-2010 school year (115.1%).

With respect to school MSEP, results show that the number of new science teachers hired into both Very Low MESP and Low MSEP schools did not replace all teachers lost to turnover (83.0% and 92.0%, respectively). In contrast, High MESP and Very High MSEP schools hired a surplus of science teachers by the 2009-2010 school year (136.4% and 125.0%, respectively).

Table 3.11
Summary results for mobility patterns and hiring patterns of high school science teachers within PRISE sample schools after two school years by school size and minority student enrollment proportion

		Stayed at a school		Departed a school		Hired by a school	
School	n	F	(%)	F	(%)	F	(%)
All Schools	385	247	64.1	138	35.9	147	106.0
Small	29	18	62.1	11	37.9	7	63.6
Medium	92	51	55.4	41	44.6	41	100.0
Large	264	178	67.4	86	32.6	99	115.1
Very Low MSEP	136	89	65.4	47	34.6	39	83.0
Low MSEP	49	24	49.0	25	51.0	23	92.0
High MSEP	68	46	67.6	22	32.3	30	136.4
Very High MSEP	132	88	66.7	44	33.3	55	125.0

Table 3.12 displays a summary profile for mobility patterns and hiring patterns of high school science teachers from Texas sample schools based on demographics by school context. Because mobility profiles were interpreted at the school level, science teachers identified as more likely to depart a school included both *movers* and *leavers*. Profiles show that Mid-Career or Veteran science teachers between the ages of 40-59 years identified as female were more likely to be retained at a Texas school. On the other hand, Novice science teachers between the ages of 20-29 years identified as female were more likely to exit schools. Departures were also noted among science teachers at least 60 years of age, which may indicate that these teachers after many years of teaching were

entering retirement. This observation was supported by findings in Table 3.2 that show across all 50 sample schools science teachers at least 60 years old were three times more likely to leave the teaching profession than to move within the profession.

In addition, there were no similarities between profiles of high school science teachers that were more likely to stay and those who were more likely to be hired. The exception to this observation was with respect to gender. New hires typically had similar teacher type and age profiles to science teachers who were more likely to leave a sample school. Because of the low percentages of minority science teachers identified in PRISE

Table 3.12

Summary profiles for mobility patterns and hiring patterns of high school science teachers within PRISE sample schools after two school years by school size and minority student enrollment proportion

	Mobility and Hiring Profile		
School	Teacher more likely to stay at a school	Teacher more likely to leave a school	Teacher more likely to be hired by a school
All Schools	Veteran teacher 40-49 years Female	Novice teacher 20-29 years Male	Novice teacher 20-29 years Female
Small	Mid-Career teacher 20-29 years Female	Veteran teacher 30-39 years or at least 60 years Male	Novice teacher 30-39 years Female
Medium	Mid-Career or Veteran teacher 40-49 years Female	Novice teacher 20-29 years or at least 60 years Male	Novice teacher 20-29 years Male
Large	Veteran teacher 40-59 years Female or Male	Novice or Mid-Career teacher 20-29 years Female or Male	Novice teacher 20-29 years Female

Note. High school science teacher profiles are based on the following demographics: teacher type, age and gender. Each demographic variable associated with a particular school context are to be interpreted independently of other variables within a profile.

Table 3.12 continued

School	Mobility and Hiring Profile: Teacher more likely to stay at a school	Teacher more likely to leave a school	Teacher more likely to be hired by a school
Very Low MSEP	Veteran teacher 40-49 years Female	Novice or Mid-Career teacher 20-29 years Male	Novice teacher 20-29 years Female
Low MSEP	Mid-Career teacher 50-59 years Female	Novice or Veteran teacher at least 60 years Male	Novice teacher 30-39 years Female
High MSEP	Mid-Career teacher 50-59 years Female	Novice teacher 30-39 years or at least 60 years Male	Novice teacher 20-29 years Female
Very High MSEP	Veteran teacher 40-49 years or at least 60 years Male	Novice teacher 20-29 years Female	Novice teacher 30-39 years Female

Note. High school science teacher profiles are based on the following demographics: teacher type, age and gender. Each demographic variable associated with a particular school context are to be interpreted independently of other variables within a profile.

sample schools, comparisons based on ethnicity were not included in profiles shown in Table 3.12.

Discussion

"[Mobility] of high-quality teachers is a recurring theme in discussions about students' achievement in science" (Stuessy et al., 2010, p. 2). High profile reports have linked highly-qualified science teachers to the preparation of future professionals who will be responsible for advancements in the education, security, and health of our nation (Ingersoll & Perda, 2009; NAS, 2007). As such, this study used descriptive statistical analyses to investigate mobility and hiring patterns of high school science teachers. Specifically, frequency analyses and cross tabs analyses were used to determine percentages of teachers classified as *stayers*, *movers*, *leavers*, and new hires in relation to teacher demographics within school contexts.

Mobility Patterns of High School Science Teachers

Findings from this study indicate that Texas public high schools lose approximately one out of three science teachers every two years. These losses climb to about two out of five and one out of two science teachers for Medium and Low MSEP schools, respectively. High turnover in Low MSEP schools contradicts previous research conducted by Scafidi et al. (2007) that suggest lower turnover among teachers in low ethnic minority student-populated schools in contrast to high minority student-populated schools. Science teachers that are more likely to be retained in a Texas school include individuals with at least three years of experience between the ages of 40-59 years identified as female.

Migration patterns suggest that science teachers are more likely to migrate to teach at a school outside the district as opposed to remaining in the same district or switching to a non-science assignment within a Texas school (data not shown). This occurrence is particularly noted among teachers moving from schools with small student populations. Migration is more likely to occur among male teachers. While experience and skills of these science educators is retained in the profession, movement of these teachers poses pecuniary and non-pecuniary expenses for schools. There is evidence also to suggest that Veteran teachers between the ages of 40-59 years are less likely to move across district lines. Variables associated with this phenomenon may include teachers having vested interests in their school and local communities, as well as concern about the transferability of salaries and benefits to receiving schools (Borjas, 2005; Grissmer & Kirby, 1987).

Attrition patterns of high school science teachers substantiate prior evidence pertaining to the U-shaped pattern of departures based on teaching experience and age (Darling-Hammond, 2000; Guarino et al., 2006; Kirby & Grissmer, 1993). This is particularly noted among Novice science teachers between the ages of 20-29 years. Because Medium-sized schools had higher proportions of Novice teachers in contrast to both Small-sized and Large-sized schools, the behavior of Novice teachers may explain why this specific school context experienced high turnover (see Table 3.4).

Regarding gender, female science teachers who although are less likely to migrate compared to male science teachers, have higher rates of attrition. Reasons for attrition among young female teachers are often associated with child-rearing responsibilities and spousal relocation (e.g., Ingersoll, 2001; Kirby et al., 1999). Therefore, attrition of female science teachers between the ages of 30-39 from schools, particularly with small student populations and moderately high ethnic minority student demographics, may indicate a delay in marriage and child-rearing in order to pursue other career and educational opportunities outside of the teaching professional continuum.

Hiring Patterns for High School Science Teachers

Hiring patterns based on teacher demographics indicate Novice science teachers between the ages of 20-29 years identified as female are the individuals most likely to be hired into Texas schools to fill vacancies (Kirby & Grissmer, 1993). These findings substantiate prior findings presented in national and state level studies (e.g., NCES, 2010;

TEA, 1995). As previously mentioned, findings suggest science teacher demographics that are more likely to be hired into Texas schools are also more likely to depart Texas schools.

A few important implications for policy and practices emerge from study findings. First, school practices are needed to increase current rates of teacher retention, particularly for Novice science teachers (Stuessy et al., 2009). Active participation of principals and experienced science teachers will be necessary to retain these teachers. Evidence suggests school communities that take a proactive approach to supporting science teachers' professional growth and excellence, as well as value their personal contributions will diversify the professional culture, strengthen science programs, and improve retention of teachers (Brown & Wynn, 2009; Ivey & Stuessy, 2009; Kardos, Johnson, Peske, Kauffman, & Lui as cited in Bozeman, 2010; Stuessy et al., 2009). Hiring teachers with shared values (i.e., fit into school culture and student-centeredness) also is linked to teacher retention (Brown & Wynn, 2009; Lewis & London, 2009).

Second, "the projections of baby boomer teacher losses in the next ten years indicate that Texas schools' current needs for high school science teachers will only increase" (Stuessy et al., 2009, p. 5). With respect to age, results from this study indicate that about one-third of the science teachers identified in 2007-2008 were approaching retirement. Losses of two out of five science teachers approaching retirement contributed to the high turnover experienced by Low MSEP schools. Schools need to be more cautious about hiring teachers in age cohorts, particularly those who are more likely to depart schools. Such actions may result in a long stream of pecuniary losses as schools seek, hire, and train replacement teachers with already stretched budgets due in part due to cuts in education funds (AEE, 2005; Brill & McCartney, 2008; Feng, 2005; National Commission on Teaching and America's Future as cited by Stuessy, 2009). Schools may also experience non-pecuniary expenses such as restructuring of professional learning communities (PLC) and science programs that may compromise student science achievement (Brill & McCartney, 2008).

Limitations

A few limitations emerged during the execution of this study. First, sample size presented a limitation for the interpretation of movement among high school science teachers. This limitation was particularly evident when making comparisons based on teacher ethnic identity. Because less than one-third of science teachers in this study were identified as ethnic minority teachers (see Tables 3.2 and 3.8), comparisons of mobility and hiring patterns based on teacher ethnicity by school size and minority student enrollment proportion (MSEP) were not conducted. However, one may consider that the low numbers of ethnic minority teachers reported in this study substantiates prior research that highlights the underrepresentation of these teachers leading classrooms (e.g., Guarino et al., 2006; Hanushek et al., 2004; Kain et al., 2004; Kirby et al., 1999). Low presence of ethnic minority teachers leading science classrooms reflects the low presence of minority students pursuing careers in science and science education (e.g., Zuniga, Olson, & Winter, 2005). Future research examining mobility and hiring patterns with sufficient numbers of ethnic minority teachers will be critical for informing hiring and retention plans for Texas high schools.

Second, collection of data for only three academic years limited descriptive statistical analyses of teacher movement with respect to teacher type, age, and gender. However, this limitation proved negligible as study findings substantiated previous research regarding mobility and hiring patterns of teachers based on these variables (Darling-Hammond, 2000; Grissmer et al., 1992; Guarino et al., 2006; Kirby & Grissmer, 1993).

Finally, the current economic conditions of the teacher labor market present limitations for implementing retention strategies suggested by study implications. Results from this study are based on data collected at the beginning of the current economic recession. Recent budget shortfalls associated with this recession has led to reductions in the Texas teacher workforce. Reductions in force (RIF) may alter teachers' mobility outcomes, both voluntarily and involuntarily, that could otherwise differ if the economy was in a more stable condition. Current circumstances suggest verification of evidence presented in this study to investigations during similar economic conditions. Continuing to examine the current teacher sample as well as conducting a longitudinal study with a larger science teacher sample size may also be beneficial to understanding mobility and hiring patterns of science teachers under different economic conditions.

CHAPTER IV

RETAINING PUBLIC HIGH SCHOOL SCIENCE TEACHERS IN TEXAS: STRATEGIES AND CHALLENGES

Reducing shortages of highly qualified teachers has been the focal point of policy makers' and education stakeholders' discussions for many years (Elfers et al., 2006). Turnover of teachers has been noted to contribute to teacher shortages in subject areas such as science (Grissmer & Kirby, 1987; Stuessy et al., 2009). High profile reports such as *A Nation at Risk* (National Commission on Excellence in Education [NCEE], 1983) and *Rising Above the Gathering Storm* (National Academy of Sciences [NAS], 2007) have directly [linked] turnover among science teachers to "the quality of education performance and, in turn, to the future well-being of the economy and the security of the [United States (U.S.)]" (Ingersoll & Perda, 2009, p. 2; Levy et al., 2006).

Current policies designed to reduce turnover of highly qualified science teachers typically fall under the umbrella of recruitment strategies. However, findings by Ingersoll and Perda (2009) suggest recruitment strategies geared toward teachers will not sufficiently address retention challenges faced by U.S. schools. Evaluating and modifying current retention strategies will be paramount to sustaining a workforce of highly qualified teachers. This chapter explores the relationships school retention strategies and school retention challenges have with science teacher retention.

Related Literature

"Retention of high-quality teachers is a recurring theme in discussions about students' achievement[s] in science" (Stuessy et al., 2010, p. 2). Teacher retention generally refers to individuals who remain in a teaching position. Conversely, teacher turnover refers to individuals who either migrate to teach at another school or depart the teaching profession (also known as attrition; Ingersoll, 2001). Each term refers to a mobility outcome of teacher employment (Bozeman, 2010).

Review of the literature suggests that intersecting labor economic models, supply and demand theory and human capital theory, have been the frameworks of choice in multiple studies examining mobility in the teacher workforce (see Guarino et al., 2006; Haggstrom et al., 1988; Hanushek et al., 2004; Ingersoll, 2006; Kirby et al., 1999). In general, supply refers to the number of qualified individuals willing to teach courses at a given salary, while demand refers to the number of teaching positions offered at a given salary (Borjas, 2005; Guarino et al., 2006). Human capital theory, on the other hand, refers to the knowledge, skills, and personal characteristics an individual accumulates over her or his lifetime (Kilburn & Karoly, 2008). The values of these characteristics are determined by an individual's potential lifetime earnings, and are therefore, considered when an individual weighs the opportunity costs and benefits for remaining in a teaching position (Bempah et al., 1994; Borjas, 2005).

While supply and demand theory and human capital theory provide simplistic models to examine mobility of the teacher workforce, a few important limitations of these models are noted. First, because both theories are salary-based there is little emphasis on the influence of independent non-salary variables on teacher mobility. Additionally, cognitive and affective processes are treated as secondary within each respective model. I posit that understanding the current state of science teacher retention extends beyond salary-based theories highlighted in labor economics. Based on this premise, in this study I use a model that takes into account the additional role of both cognitive and non-salary variables.

Social learning theory allowed me to analyze science teacher retention from the viewpoint of the continuous process of reciprocal determinism. Reciprocal determinism is a model proposed by Bandura (1977,1978) that centers on the triadic interaction between cognitive, behavioral, and environmental variables (see Figure 4.1). “In this triadic reciprocal determinism…*reciprocal* is defined as the mutual action between [variables, whereas] *determinism* signifies the production of effects by [variables]” (Bandura, 1983, p.166). Using the school as the level of analysis, I employed reciprocal determinism to examine how retention strategies and retention challenges within the school environment determine retention rates of high school science teachers.

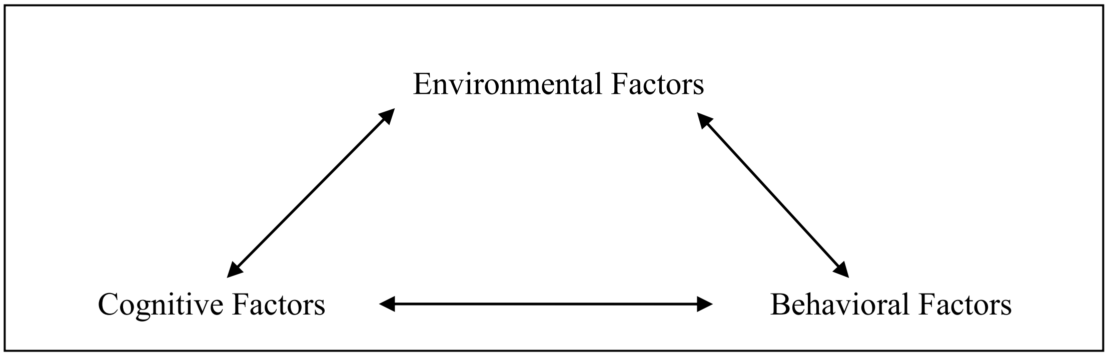

Figure 4.1 Schematic adaption depicting triadic relationship between environmental, cognitive, and behavioral factors as suggested in reciprocal determinism. Adapted from "The Self System in Reciprocal Determinism," by A. Bandura, 1977, *American Psychologist, 33*(4), p. 345.

Mounting evidence suggest school environment variables such as administrative support, salary, working conditions, and student demographics are associated with science teacher mobility (e.g., Borman & Dowling, 2008; Brown & Wynn, 2009; CAE, 2004; Ivey & Richardson, 2007; Kirby & Grissmer,1993; Kukla-Acevedo, 2009; Weiss, 1999). For instance, school administrators that foster professional communities within schools, nurture the professional growth of teachers at all career levels, develop lines of communication with and among faculty, and provide an infrastructure for tangible and intangible supports, have success at retaining teachers (Block, 2008; Brown & Wynn, 2009; CAE, 2004; Ivey, 2007; Ivey & Stuessy, 2009). Consequently, poor administrative support has been linked to both job dissatisfaction and turnover among teachers (Hean & Garrett, 2001; Ingersoll, 2001; Stockard & Lehman, 2004).

Schools that provide competitive salaries and other monetary incentives (Metty & Ivey, 2007) also have the increased likelihood of retaining teachers. Monetary incentives include differential pay and performance pay plans that were typically designed to recruit and retain highly qualified teachers in shortage subject areas such as science, and disadvantaged schools (Brown, et al., 2010; Kirby & Grissmer, 1993; Moran, 2007). In addition, these incentive plans have also been used to offset the costs of standardized salary schedule increases. This is an important consideration given that females, who dominate the teacher workforce, were less responsive to salary increases once they decided to depart a school (Hanushek et al., 2004; Kain et al., 2004). The costs of increasing salaries on standardized schedules to keep these teachers would become extremely expensive.

In regard to working conditions, schools that provide adequate support for student behavior management, autonomy for decisions within the classroom, and facilities for instruction experienced few turnovers among teachers (Borman & Dowling, 2008; Kukla-Acevedo, 2009). For instance, a study conducted by Kukla-Acevedo revealed that student behavior management and classroom autonomy both had a direct influence on the retention decisions of beginning teachers (2009). In addition, a review of the literature conducted by Metty and Stuessy (2007) suggested provision of well-equipped science facilities and adequate classroom space not only influenced teacher retention, but also teacher instruction and student learning opportunities.

With respect to student demographics, literature sources concur teachers preferred to teach at schools that had high populations of high-achieving, high-income, White students (Clotfelter et al., 2004; Hanushek et al., 2004; Lankford et al., 2002; Scafidi et al., 2007). These findings were irrespective of age, gender, and years of teaching experience (Borman & Dowling; 2008). Conversely, schools that have high populations of low-achieving, low-income, high racial minority students tend to have higher rates of teacher turnover (Hanushek et al., 2004). Students attending these schools usually are taught by less experienced, less qualified teachers (Lankford, et al., 2002). The ramifications of this phenomenon suggest an education system that is “separate and unequal” (U.S. Department of Education [ED], 2003, p. 4). Current initiatives, such as loan forgiveness programs and increased salaries used to increase retention of highly qualified teachers in these types of schools have produced mediocre results (Lankford et al., 2002). Effective policy alternatives are still needed in this particular area.

In summary, previous studies indicate that schools employing more retention strategies will have higher retention rates as opposed to schools that do little to retain high school science teachers. Schools that are able to both identify challenges to retain teachers and develop strategic plans to address turnover would also have higher retention rates of teachers.

Purpose of This Study

At this time, little emphasis has been placed on exploring strategies specific to the retention of science teachers. Furthermore, current investigations have yet to inquire about the challenges that schools face to retain teachers. The purpose of this study is to investigate the relationships among retention strategies, retention challenges, and high school science teacher retention. Specifically, I provide evidence to answer the following research questions:

Research Question 1: What are the types and distribution of reported retention strategies implemented within high schools to retain science teachers?

Research Question 2: What are the relationships between reported retention strategies and science teacher retention rates?

Research Question 3: What are the types and distribution of reported retention challenges occurring within high schools to retain science teachers?

Research Question 4: What are the relationships between reported retention challenges and science teacher retention rates?

Context of Study

This study was conducted in conjunction with the Policy Research Initiative in Science Education (PRISE) research study which objective was to investigate the state-of-the-state of Texas high school science teacher professional continuum (TPC). “Conceptually, the high school science TPC refers to the professional lives of high school science teachers along the continuum of their recruitment, induction, renewal, and [retention] in the teaching profession” (Stuessy et al., 2010, p. 7). The five-year PRISE research study seeks to answer three essential policy research questions about the high school science TPC in Texas: *Where are we?*, *Where do we want to go?*, and *How do we get there?*

Research Design

For this study I took a pragmatic, mixed methods approach “to query and analyze complex data sets of interviews…and archival data to investigate relationships between and among variables in the Texas high school science TPC” that deal with teacher retention (Stuessy, 2010, p. 2). Specifically, qualitative research methods introduced by Chi (1997) allowed me to gain an inductive understanding about retention strategies and retention challenges for teachers occurring within and across sample schools. *School* in the current study refers to (a) Texas public schools where high school science is offered and (b) administrator or district policies and strategies implemented at the school level. Quantitative research methods such as descriptive statistical analyses allowed me to deduce trends and make generalizations about retention of science teachers in sample schools. Abductive reasoning allowed me to move back and forth between both induction and deduction processes to determine relationships among study variables. A sequential exploratory design, as described by Creswell and Clark (2007), served as the mixed methods research design for this study. The combination of these two approaches presents a rich picture regarding the current state of retention for high school science teachers in Texas public schools.

Methods

Sampling Plan

A modified, stratified random sampling plan described by McNamara and Bozeman (2007) was used to identify a scientific sample of 50 schools to represent the 1,333 public schools in Texas that offer high school science courses. Two explicit stratification variables were used simultaneously to create the representative sample: (1) a three-level classification variable indicating the *size of student enrollment*, (i.e., Small, Medium, and Large), and (2) a four-level classification variable indicating the *minority student enrollment proportion* (MSEP; i.e., Very Low, Low, High, and Very High). A third implicit stratification variable, school geographic location, was also included "to assure a sample yielding results that were representative of all Texas [public] high schools" (Stuessy, 2009, p. 3).

Table 4.1 shows participation rates for sample schools selected by the sampling plan. Thirty-nine of the sample schools randomly selected agreed to participate in the PRISE research study (78.0% participation rate). The schools that declined participating in this study were replaced with eleven schools that had similar characteristics. Overall, the school participation rate reached 100.0%. "Chi-square tests empirically supported population validity [of the sampling plan] (chi-square = 0.867, df = 11; $p_{crit} = 19.675$)" (Stuessy, 2009, p. 2). The second stage of the sampling plan consisted of identifying teachers at each of the 50 sample schools who taught at least one high school science course. Overall, 385 science teachers were identified at sample schools. The second stage did not require random selection of teachers. Teachers who agreed to participate returned a completed consent form. Table 4.1 also shows that overall participation rate of teachers was approximately 89.2%. Science teachers received a small stipend for their participation in the PRISE research study.

Table 4.1
Participation rates of the 50 sample schools and 385 high school science teachers in the PRISE research study

School Participation Status	Total Teacher Sample Frequency Count	Teacher Participation Status Frequency Count	Participation Rate of Teachers (%)
Random (n = 39)	316	280	88.6
Replacement (n = 11)	69	63	91.3
Total	385	343	89.2

Data Collection

High School Principal Interviews. Development of the PRISE Administrator Interview Protocol in 2007 consisted of "processes of dialogue, item writing, pilot testing, reflection, and revision" (Bozeman & Stuessy, 2009, p. 2) among PRISE researchers. Questions included in this semi-structured interview centered on the recruitment, induction, renewal, and retention of high school science teachers. Table 4.2 shows interview questions specific to teacher retention. Beginning January 2008, PRISE research fellows underwent the task of conducting interviews with high school principals of the 50 sample schools. Interviews were conducted either face-to-face or over the telephone. Researchers recorded fieldnotes and/or audio-taped interviews after receiving verbal and written consent from the participant. Acquired interviews were then transcribed, organized into datacharts, and archived into the PRISE School Database. Conducting interviews with principals and archiving of data continued until September 2008. Responses specific to retention strategies and retention challenges identified in archived interviews were used for further analyses in this study.

Table 4.2
Retention questions from the PRISE Administrator Interview Protocol

Retention Questions[1]
• How does teacher retention work in your school?
• Explain your school's current teacher retention procedures.
• Identify "what works best" in your school's current teacher retention procedures.
• Do you see teacher retention issues or concerns that are likely to emerge in the immediate future at your school? (Elaborate these issues and concerns.)
• Do you have plans to change your school's current teacher retention process? (Elaborate these changes and how they might affect your retention efforts.)
• How might our network help you with teacher retention at your school? (Elaborate.)
• Is there anything else that you would like to tell us about retention at your school?
• Is there anything else that you would like to tell us about retention that you think would be helpful to share with the network and/or with the population of schools that teach high school science?

Note. [1]High school principals were asked to provide their perspectives about teacher retention both general for all subjects and specific to high school science.

High School Science Teachers. School master schedules and teacher lists were collected from the 50 sample schools in academic years 2007-2008 and 2008-2009 by PRISE researchers. This information was used to identify sample teachers who taught high school science courses at their respective schools. To ensure confidentiality, codes were assigned to each science teacher prior to archival in the PRISE Teacher Database. In addition, the Public Education Information Management System (PEIMS), a division within the Texas Education Agency (TEA), was queried to obtain information about sample teachers' course assignments and demographics (e.g., gender, ethnicity, date of birth, total years of teaching experience, and highest degree obtained). This data was also collected and archived for academic years 2007-2008 and 2008-2009.

Data Analysis

Development of Weighted Retention Scoring Rubrics. Verbal analysis as described by Chi (1997) was employed to reduce and select sentence statements related to retention strategies as reported by high school principals. A "tentative taxonomic categorical system" as proposed by Stuessy and Ivey (2010, p. 7) was implemented to sort and organize main categories, sub-categories, and individual strategies reported by principals into a rubric. At least two principals had to report using a specific strategy for it to be included on the rubric. Names of main, sub-category, and individual retention strategies displayed on the rubrics were based on commonalities shared among reported strategies. The same reducing, selecting, categorizing, sorting, and naming processes were also implemented to develop the retention challenge rubric. "Inter-rater reliability was established for resulting rubrics between pairs of [peers] who evaluated the interviews from principals until the pair reached at least [85.0%] agreement" (Stuessy & Ivey, 2010, p. 7). A panel of peers also negotiated weights for each main category and individual items for both retention rubrics. The organization and principals' responses on retention rubrics appear in the Results section of this chapter.

Retention Strategy Factors and Retention Challenge Factors. A series of data reduction strategies were conducted in order to identify retention strategies and retention challenges that explained the most variance in responses of sample schools for each respective rubric. The first data reduction strategy consisted of identifying the most frequent strategies and challenges occurring in sample schools.

As shown in Table 4.3, frequencies of occurrence for the 52 individual retention strategies reported by high school principal interviews ranged from two to twelve schools (4.0% to 24.0%). Because frequency counts were low, the 23 most frequent retention strategies were selected for further data reduction. Likewise, frequencies of occurrence for the 33 individual retention challenges reported by principals in interview transcripts were also low, ranging from two to thirteen schools (4.0% and 26.0%). The sixteen most frequent retention challenges shown on Table 4.4 were also selected for further analyses.

Table 4.3
Frequency counts of retention strategies as reported by high school principals (n = 52)

Retention Strategy	Frequency Count	(%)
This school has good relationships among staff members	12	24.0
This school provides teachers autonomy in decisions pertaining to school level and classroom level practices	10	20.0
This school has an open door policy for teachers	10	20.0
This school provides science teachers with satisfactory science facilities	9	18.0
This school expresses and shows appreciation for teachers	8	16.0
This school provides pay raise or loyalty pay incentives for teachers	8	16.0
This school is located in a favorable environmental and physical location for teachers	8	16.0
This school supports a comfortable teaching environment	8	16.0
This school provides teachers with adequate instructional materials	8	16.0
This school exercises staff termination for unsuccessful teachers	8	16.0
This school provides classroom placements and assignments that are best fit for the science teacher	7	14.0
This school assists and supports teachers with student discipline	7	14.0
This school recognizes teachers as having a vital role within the school community	7	14.0
This school conducts ongoing teacher assessment	7	14.0
This school encourages teachers to take ownership within the classroom and science program	6	12.0
This school provides a competitive salary to retain teachers	6	12.0

Note. Frequency count and percentages of retention strategies are based on occurrence across sample schools.

Table 4.3 continued

Retention Strategy	Frequency Count	(%)
This school has presence of administrative leadership	6	12.0
This school encourages collaboration among colleagues	6	12.0
This school identifies implemented induction practices as also a means to retain teachers	6	12.0
This school has social events to show appreciation and encourage camaraderie among teachers	5	10.0
This school provides teachers with planning time	5	10.0
This school provides teachers with sufficient technology resources	5	10.0
This school ensures teachers have access to non specific supplies and resources	5	10.0
This school recognizes teachers either individually or as a group for their efforts	4	8.0
This school provides a science specific stipend for science teachers	4	8.0
This school is located where a teacher has family ties	4	8.0
This school supports ongoing growth and improvement of teachers	4	8.0
This school provides a safe teaching environment	4	8.0
This school provides personal time for teachers	4	8.0
This school identifies implemented recruitment practices as also a means to retain teachers	4	8.0
This school identifies implemented professional development practices as also a means to retain teachers	4	8.0
This school provides miscellaneous monetary incentives to retain teachers	3	6.0
This school has a program set up for teachers to increase retirement savings	3	6.0
This school receives community support	3	6.0
This school has good relationships among students and teachers	3	6.0
This school supports a school community that cares for one another	3	6.0
This school has a sense of community	3	6.0
This school promotes a student centered environment	3	6.0
This school alleviates teacher workload	3	6.0
This school provides a small class size for teachers	3	6.0
This school provides departmental funding	3	6.0
This school rewards teachers for having high attendance throughout the school year	2	4.0
This school provides insurance benefits for teachers	2	4.0
This school provides subsidizing incentives such as relocation expenses, housing or daycare for teachers	2	4.0
This school is located in a community that has favorable economic circumstances	2	4.0
This school receives parental support	2	4.0
This school promotes teacher leadership	2	4.0
This school promotes shared leadership between principals and teachers	2	4.0
This school has a supportive science department	2	4.0
This school treats teachers as professional	2	4.0
This school has a good academic reputation	2	4.0
This school has a good student reputation	2	4.0

Note. Frequency count and percentages of retention strategies are based on occurrence across sample schools. Dashed line indicates cutoff of high frequencies of occurrence and low frequencies of occurrence of retention strategies.

Table 4.4

Frequency counts of retention challenges as reported by high school principals (n = 33)

Retention Challenge	Frequency Count	(%)
This school does not provide a competitive salary for teachers	13	26.0
This school experiences challenges with replacing experienced teachers approaching retirement	8	16.0
This school loses teachers who seek science industry employment	7	14.0
This school loses teachers to gas and travel expenses	7	14.0
This school lacks support for new teachers	7	14.0
This school loses teachers who are interested in coaching positions	6	12.0
This school loses teachers to health and personal family issues	6	12.0
This school has a history of teacher turnover	6	12.0
This school has teachers that struggle to acclimate to culturally diverse student demographic	5	10.0
This school losses time and monetary training expenditures when a teacher leaves	5	10.0
This school loses teachers who seek administrative positions	4	8.0
This school loses teachers who are dissatisfied or incompatible with teaching	4	8.0
This school loses teachers who have a low desire to live in the local community	4	8.0
This school has issues with meeting 4X4 Legislation and teacher certification requirements	4	8.0
This school is experiencing downsizing or possible closure	4	8.0
This school has issues with losing teachers during the school year	4	8.0
This school loses teachers to competitive school districts that provide science specific stipends and bonuses	3	6.0
This school loses teachers who have spouses that relocate	3	6.0
This school assigns teachers an increased number of preps and classes	3	6.0
This school has teachers who are pressured with time commitment and constraints	3	6.0
This school has issues with student discipline	3	6.0
This school loses teachers seeking a better retirement salary	3	6.0
This school experiences dissonance between teacher needs and district supports	3	6.0
This school experiences accountability issues from the state	3	6.0
This school experiences challenges with replacing experienced science teachers approaching retirement	3	6.0
This school loses teachers who pursue graduate or professional degrees	2	4.0
This school loses teachers to competitive school districts that steal science teachers	2	4.0
This school loses teachers to competitive school districts that provide teachers a reduction in preps and course load	2	4.0
This school assigns teachers extra duties and roles	2	4.0
This school has limited lab space for science teachers to use	2	4.0
This school has inadequate budgets and supplies or outdated technology to support student learning	2	4.0
This school needs improvements in staff relationships and appreciation	2	4.0
a negative impact on student learning as a cost of teacher turnover	2	4.0

Note. Frequency count and percentages of retention challenges are based on occurrence across sample schools. Dashed line indicates cutoff of high frequencies of occurrence and low frequencies of occurrence of retention challenges.

The second step employed factor analysis to further reduce the 23 retention strategies into factors. Factor analysis with Varimax rotation yielded the following four retention strategy factors: (1) Autonomy and Access, (2) Staff Relationships, (3) Appreciation, and (4) Collaboration Among Staff (see Table 4.5). Names of factors were based on commonalities shared between extracted retention strategies. According to Table 4.6, eigenvalues of strategy factors explained approximately 70.0% of the total variance in the retention strategy rubric responses.

Table 4.5
Four principal factors reduced from factor analysis with Varimax Rotation of reported retention strategies

Individual Retention Strategies	Factors			
	1	2	3	4
This school provides teachers autonomy in decisions pertaining to school level and classroom level practices	0.769	-0.222	0.229	0.352
This school ensures teachers have access to non-specific supplies and resources	0.667	-0.205	0.383	-0.246
This school has presence of administrative leadership	-0.662	-0.333	-0.002	0.131
This school has good relationships among staff members	-0.047	0.788	-0.209	-0.023
This school has an open door policy for teachers	0.016	0.654	0.349	0.098
This school expresses and shows appreciation for teachers	-0.007	-0.018	0.851	-0.174
This school encourages collaboration among colleagues	-0.042	0.048	-0.161	0.924

Table 4.6
Variance explained by four principal factors reduced from factor analysis of individual retention strategies on the retention strategy scoring rubric

Factors and Retention Strategy Items[1]	Eigenvalue	Variance Explained (%)	Cumulative Variance Explained (%)
Autonomy and Access (items 1, 22, 46)	1.52	21.64	21.64
Staff Relationships (items 23, 33)	1.20	17.12	38.76
Appreciation (item 4)	1.17	16.76	55.52
Collaboration Among Staff (item 29)	1.00	14.34	69.86

Note. [1]Retention strategy item numbers are based on organization of the retention strategy scoring rubric.

With respect to retention challenges, sixteen were reduced by factor analysis to yield the following five factors: (1) Personal Circumstances, (2) Teacher Certification and Training Issues, (3) Community Characteristics, (4) Employment Opportunities Outside Education, and (5) Employment Opportunities Within Education (see Table 4.7). Eigen values shown in Table 4.8 indicate that extracted retention challenges explained approximately 91.0% of the total variance in the retention challenge rubric responses.

Table 4.7

Five principal factors reduced from factor analysis with Varimax Rotation of reported retention challenges

Individual Retention Challenge Items	Factors				
	1	2	3	4	5
This school loses teachers who are dissatisfied or incompatible with teaching	0.840	0.061	-0.179	0.366	0.138
This school loses teachers to health and personal family issues	0.743	-0.038	0.481	-0.309	0.047
This school loses time and monetary training expenditures when a teacher leaves	0.238	0.869	-0.168	-0.182	-0.219
This school has issues with meeting 4X4 Legislation and teacher certification Requirements	-0.273	0.793	0.253	0.190	0.323
This school loses teacher who have a low desire to live in the local community	0.015	0.017	0.950	0.072	-0.058
This school loses teachers who seek science industry employment	0.079	-0.031	0.057	0.954	-0.081
This school loses teachers who seek administrative positions	0.123	0.000	-0.059	-0.083	0.965

Table 4.8

Variance explained by five principal factors reduced from factor analysis of individual retention challenges on the retention challenge scoring rubric

Factors and Retention Challenge Items[1]	Eigenvalue	Variance Explained (%)	Cumulative Variance Explained (%)
Personal Circumstances (items 8, 10)	1.52	21.71	21.71
Teacher Certification and Training Issues (items 26, 30)	1.39	19.87	41.59
Community Characteristics (item 11)	1.24	17.70	59.29
Employment Opportunities Outside Education (item 4)	1.22	17.35	76.64
Employment Opportunities Within Education (item 3)	1.04	14.83	91.47

Note. [1]Retention challenge item numbers are based on organization of the retention challenge scoring rubric.

Science Teacher Retention Rates. "Retention rates of the 385 high school science teachers were calculated using schools' master schedules [and teachers lists] for two consecutive years, triangulated with state-maintained data" (Stuessy et al., 2010, p. 16).

> Names of science teachers retained from 2007-2008 to teach science in 2008-2009 [appeared] on both lists. The proportion of teachers remaining from one year to the next was determined to be the retention rate for high school science teachers at the school. (Stuessy et al., 2009, p. 2)

Calculations for retention rates of teachers were conducted at the school level. Table 4.9 shows descriptive statistics for science teacher retention rates for all 50 sample schools. Teacher retention rates averaged approximately 75.4% (SD = 24.6). In addition, Table

4.9 shows descriptive statistics for other school-level variables that were analyzed for this study.

Table 4.9
Descriptive statistics for study variables

Variable Name	Description, Source, and Development of Measure	Descriptive Statistic for All Sample Schools (n = 50)
Retention Strategies	Principal interview data scored on a rubric with weighted values	Mean = 17.8 SD = 10.2 Median = 18.0 Minimum = 0 Maximum = 43
Retention Challenges	Principal interview data scored on a rubric with weighted values	Mean = 9.7 SD = 10.6 Median = 6.0 Minimum = 0 Maximum = 43
School Size	University Interscholastic League classification was used to classify each school as Small (1A), Medium (2A, 3A), or Large (4A, 5A)	Small = 15 Medium = 17 Large = 18
School Minority Student Enrollment Proportion	Minority student proportion was used to classify each school as either Very Low (< 35%), Low (35% - 49%), High (50% - 74%), or Very High (75% - 100%), as per Texas state databases	Very Low = 21 Low = 8 High = 9 Very High = 12
Retention Rate	Percentage of science teachers from 2007-08 school year who remained for the 2008-09 school year; master schedules to identify remaining teachers; PEIMS database to determine location in the next year	Mean = 75.4 SD = 24.6 Median = 80.0 Minimum = 0.0 Maximum = 100.0

Relationships among School Level Variables. I used descriptive analyses to examine the extent specific types of retention strategies were used in Texas sample schools to retain high school science teachers. Types of retention strategies refer to the main category groupings that emerged from verbal analysis and coding of high school principal interviews. Each school received a weighted score for each strategy type. Mean scores for each strategy type were computed for all 50 sample schools, as well as by school size and minority student enrollment proportion (MSEP). The same process was conducted to examine the extent types of retention challenges for science teachers were experienced by schools.

I also explored relationships between retention strategies and retention rates of high school science teachers across all 50 sample schools by process of regression analyses. Specifically, two simple linear regression models and a multiple linear regression model were used to examine how well retention strategies predicted retention rates. The predictor for the first simple linear regression model was weighted Total Retention Strategy Score. Because descriptive statistical analyses of the sample schools revealed low frequency counts of retention strategies, a simple linear regression was also conducted with the weighted composite score of the most frequent retention strategies (i.e., the 23 most frequent retention strategies). A multiple linear regression was used to model retention rates using retention strategy factors. The same process was conducted to examine the relationships between retention challenges and retention rates. Because retention factors explained the most variance in respective rubric responses, these variables were used in regression models as opposed to mean scores based on retention strategy and retention challenge types. In addition, because the data for retention strategies, retention challenges, and retention rates variables "were collected using different scales of measurement, a z-score transformation was performed, and the [regression analyses were] computed using the z-score values" (Norusis cited in Chapman, Synder, & Burchfield, 1993, p. 309).

Descriptive statistical analyses were also employed to examine the relationships between school retention strategies and school retention status for high school science teachers. Specifically, weighted Total Retention Strategy Score and retention strategy factors were converted into quartile rank score distributions to make comparisons between High-Retention and Low-Retention schools. Twenty-six schools classified as High-Retention had science teacher retention rates above the mean rate of 75.4% for all 50 schools. Twenty-four schools classified as Low-Retention had teacher retention rates that fell below the mean rate. Quartile rank score distributions were computed for each school context. With respect to minority student enrollment proportion (MSEP), sample schools with less than 50.0% minority student demographics were combined into one variable, Low MSEP. Sample schools with minority student demographics greater than 50.0% were combined into one variable, High MSEP. This procedure was performed in order to alleviate sample size limitations that arose during this study. School sizes, i.e., Small, Medium, and Large, were not combined to increase sample size among groups.

Results

Types and Distribution of Retention Strategies

Verbal analysis of high school principal interviews identified 52 reported retention strategies used across 50 sample schools to retain science teachers in the 2007-2008 school year. Figure 4.2 shows the frequencies of occurrence and applied weights for strategy items on the retention strategy scoring rubric. The five retention strategy categories that emerged from analysis of interview transcripts included: (1) Providing Individual Teacher Supports, (2) Marketing a Positive Local Community, (3) Marketing a Positive School Community, (4) Marketing a Positive Work Environment, and (5) Career Enhancement Practices. Approximately two-thirds (64.0%) of individual retention strategies were classified as either Marketing a Positive School Community (n=19) or Providing Individual Teacher Supports (n=14; see Figure 4.2). *Relationships among staff members* was the most frequently reported retention strategy, occurring in 24.0% of the sample schools, followed by the provision of *open-door policies* and *autonomy in school-level and classroom-level practices*, which both occurred in 20.0% of the sample schools. Of the five strategies specified for the retention of science teachers: *ownership within classroom and science program*; *classroom and assignment is best fit for science teacher*; *science-specific stipend*; *supportive science department;* and *satisfactory science facilities*, *satisfactory science facilities* was the most frequently reported strategy occurring in 18.0% of the sample schools.

Providing Individual Teacher Supports (3)														**Marketing a Positive Local Community (1)**				
Autonomy			Appreciation				Pecuniary Incentives											
Decision-making (2)	Ownership within classroom & science program (2)	Classroom placement is best fit for science teacher (2)	Staff appreciation (1)	Teacher recognition (2)	Social events (1)	Attendance awards (1)	Insurance (3)	Subsidizing benefits, i.e., relocation, housing & daycare (3)	Pay raises & loyalty pay (1)	Other monetary incentives (1)	Retirement programs (2)	Competitive salary (2)	Science-specific stipend (1)	Environment/Physical location (2)	Local economics (1)	Family ties (2)	Parental support (1)	Community support (1)
10	6	7	8	4	5	2	2	2	8	3	3	6	4	8	2	4	2	3

Marketing a Positive School Community (2)																			
Leadership			Administrative Support				Supportive & Safe		School Culture & Collegiality										
Presence of teacher leadership (1)	Presence of shared leadership (3)	Presence of administrative leadership (2)	Open-door policies (1)	Assist with student discipline (1)	Appeal to district for teachers' needs (1)	Comfortable teaching environment (2)	Safe teaching environment (1)	Supportive science department (1)	Collaboration among colleagues (1)	Treated as professionals (3)	Good academic reputation (1)	Recognized as having vital role to school (3)	Relationships with staff members (2)	Student-teacher relationships (3)	Good student reputation (1)	Care for teachers (1)	Sense of community (2)	Student-centered environment (2)	
2	2	6	10	7	4	8	4	2	6	2	2	7	12	3	2	3	3	3	

Marketing a Positive Work Environment (2)									**Career Enhancements Practices (2)**				
Work Load				Resources									
Alleviation of workload (1)	Provide planning time (3)	Class size (1)	Provide personal time (2)	Technology (1)	Science facilities (1)	Instructional materials (1)	Other nonspecific supplies (1)	Departmental funding (3)	Ongoing teacher assessment (2)	Termination of unsuccessful staff (1)	Recruitment practices (1)	Induction practices (2)	Professional development opportunities (2)
3	5	3	4	5	9	8	5	3	7	8	4	6	4

Note. Weights appear in parentheses after main category and individual retention strategies. Frequencies appear in the same column of the individual strategies.

Figure 4.2 Retention strategies scoring rubric based on verbal analysis of high school principal interview responses.

Table 4.10 shows the types and distributions of reported retention strategies based on size and minority student enrollment proportion (MSEP). The mean total retention strategy score for all 50 sample schools was approximately 18.0 with a standard deviation of about 10.2. The total retention strategy score range of 0.0 to 43.0 for sample schools fell below 187.0, the highest score a sample school could receive (data not shown). Mean score statistics also revealed low total score and main category scores for all 50 sample schools regardless of school context. Provision of Individual Strategies had the highest mean score across all school contexts with the exception of High MSEP schools. Marketing a Positive School Community category received the highest score for High MSEP schools. Marketing a Positive Local Community, however, received the lowest mean scores across all schools regardless of context. Taking standard deviations into account, no notable differences were observed between retention strategy scores for sample schools. This observation was irrespective of school context.

Table 4.10

Types and distribution of rubric retention strategies by size and minority student enrollment proportion

		Retention Rubric Strategy Categories											
		Providing Individual Teacher Supports		Marketing a Positive Local Community		Marketing a Positive School Community		Marketing a Positive Work Environment		Career Enhancement Practices		Total Strategy Score	
School	n	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
All Schools	50	6.84	6.36	0.62	1.07	5.92	5.31	2.60	3.11	1.84	2.21	17.82	10.17
School Size													
Small	15	7.00	6.68	1.00	1.07	4.80	4.26	2.27	3.69	1.07	1.49	16.13	10.62
Medium	17	5.65	5.70	0.29	0.99	5.29	5.70	2.94	3.09	2.35	2.57	16.53	11.35
Large	18	7.83	6.99	0.61	1.09	7.44	5.65	2.56	2.73	2.00	2.28	20.44	8.51
Minority Student Enrollment Proportion													
Very Low	21	6.43	6.24	0.71	1.15	5.71	5.52	2.57	3.41	1.62	2.16	17.05	10.71
Low	8	6.00	5.07	0.75	1.04	4.75	6.50	3.00	2.62	1.75	1.89	16.25	8.41
High	9	7.33	6.73	0.89	1.36	8.22	4.29	1.11	1.45	1.33	2.00	18.89	6.74
Very High	12	7.75	7.61	0.17	0.58	5.33	4.92	3.50	3.63	2.67	2.61	19.42	12.94

Note. M = Mean; SD = Standard Deviation. Highest possible weighted score based on the retention strategy scoring rubric was 187.00. Score range of weighted total retention strategies for sample schools was 0.00 to 43.00.

Relationships among Retention Strategies and Science Teacher Retention

The following two simple linear regressions models were developed to determine relationships between retention strategies and retention rates of high school science teachers: (1) weighted Total Retention Strategy Score and (2) weighted most frequent retention strategies score. Results in Table 4.11 and Figure 4.3 indicate a very weak, direct relationship between Total Retention Strategy Score and retention rates. This relationship was not statistically significant with a p-value equal to 0.508. Table 4.12 shows the amount of variance in retention rates explained by Total Retention Strategy Score was only 1.0%. A simple linear regression model predicting retention rates with most frequent retention strategies score computed similar results (data not shown).

Table 4.11
Regression coefficient for simple linear regression model describing retention rates of high school science teachers using weighted Total Retention Strategy Score

	Unstandardized Coefficients		Standardized Coefficients	t-value	Sig.
	B	SE	Beta		
Constant	0.000	0.142		0.000	1.000
Total Retention Strategy Score	0.096	0.144	0.096	0.668	0.508

Note. SE = Standard Error.

Table 4.12
ANOVA values for simple linear regression model describing retention rates of high school science teachers using weighted Total Retention Strategy Score

	Sum of Squares	df	Mean Square	F ratio	Sig.
Regression	0.451	1	0.451	0.446	0.508
Residual	48.549	48	1.011		
Total	49.000	49			

Note. df = degree of freedom.

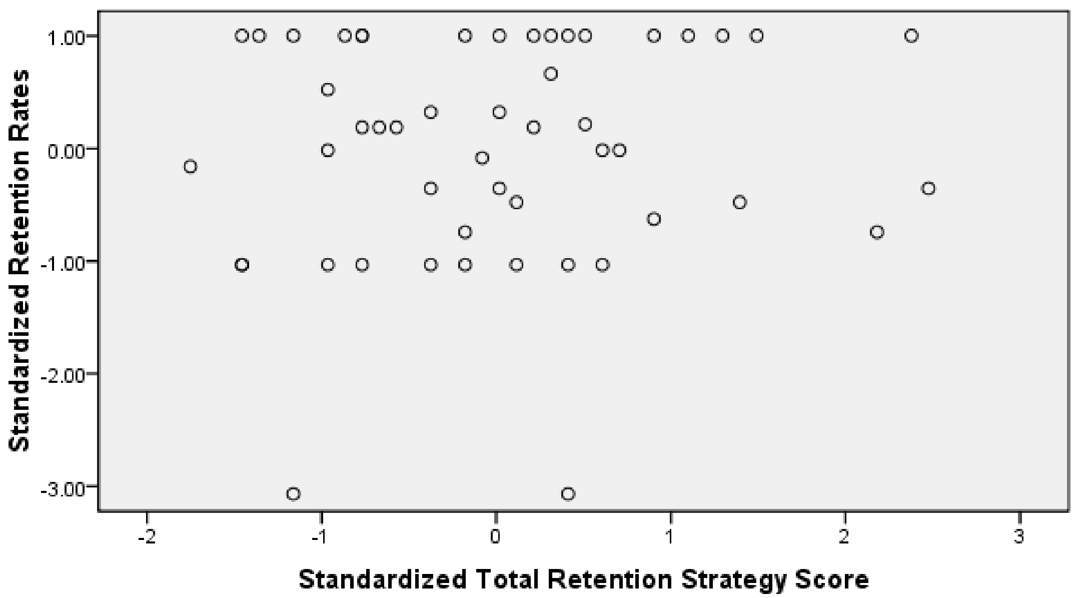

Figure 4.3 Scatter plot of retention rates of high school science teachers predicted by weighted Total Retention Strategy Score.

Table 4.13 and Figure 4.4 show the multiple linear regression model that was used to analyze the prediction of retention strategy factors. Results for this study indicated no relationships of significance among study variables. Retention strategy factors had either no observable relationship (i.e., Autonomy and Access, Collaboration

Among Staff, and Staff Relationships) or a very weak direct relationship (i.e., Appreciation) to retention rates. Table 4.14 shows the amount of variance in retention rates explained by retention strategy factors was 3.0%, a marginal increase from the simple linear regression model presented in Tables 4.11 and 4.12.

Table 4.13
Regression coefficient for multiple linear regression model describing retention rates of high school science teachers using retention strategy factors derived from factor analysis

	Unstandardized Coefficients		Standardized Coefficients	t-value	Sig.
	B	SE	Beta		
Constant	0.000	0.145		0.000	1.000
Autonomy and Access	0.011	0.147	0.011	0.076	0.940
Staff Relationships	0.091	0.147	0.091	0.621	0.537
Appreciation	0.147	0.147	0.147	1.005	0.320
Collaboration Among Staff	0.053	0.147	0.053	0.363	0.718

Note. SE = Standard Error.

Table 4.14
ANOVA values for multiple linear regression model describing retention rates of high school science teachers using retention strategy factors

	Sum of Squares	df	Mean Square	F ratio	Sig.
Regression	1.615	4	0.404	0.384	0.819
Residual	47.385	45	1.053		
Total	49.000	49			

Note. df = degree of freedom.

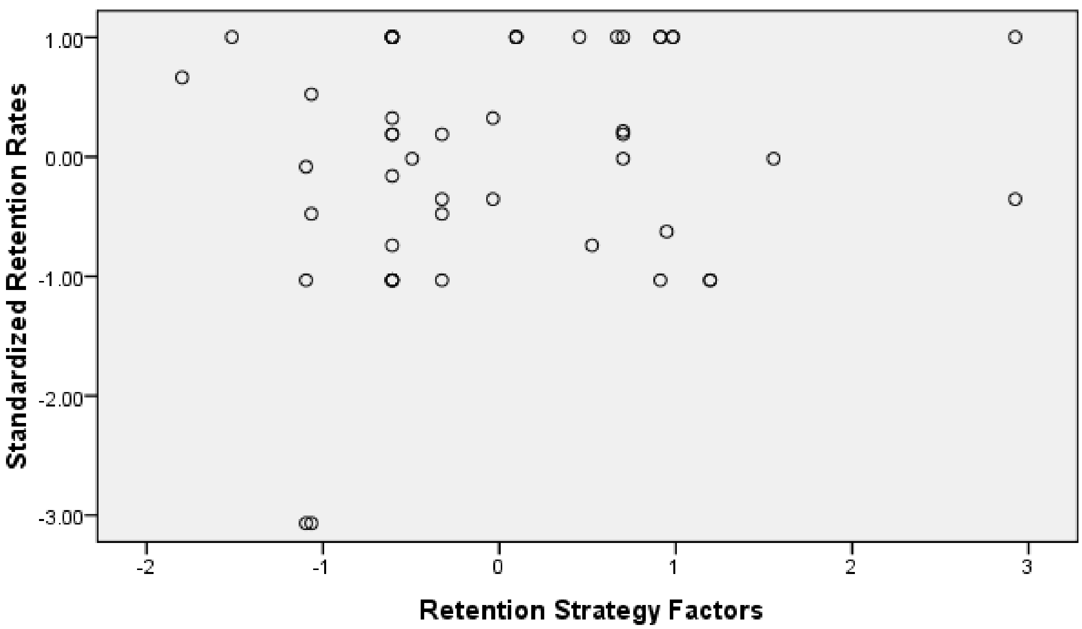

Figure 4.4 Scatter plot of retention rates of high school science teachers predicted by four retention strategy factors.

Relationships among Retention Strategies and Science Teacher Retention by School Context

Table 4.15 compares quartile rank score distributions for weighted Total Strategy Retention Score in Low-Retention and High-Retention schools by size and minority student enrollment proportion (MSEP). Results show that Medium-sized High-Retention schools had higher percentages of rank scores collectively in the 3rd and 4th quartiles (upper quartiles) in contrast to respective Low-Retention schools. Both Small-sized and Large-sized schools, however, had similar distributions in rank scores regardless of retention status.

With respect to minority student enrollment proportion (MSEP), both Low MSEP and High MSEP schools had similar patterns in rank scores regardless of High- or Low- retention status.

Table 4.15

Distributions of quartile rank scores based on Total Retention Strategy Score in Low- and High-Retention schools by size and minority student enrollment proportion

Schools	n	Percentages of Occurrence of Strategy Score by Quartile Rank 1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Small					
Low-Retention	5	20.00	40.00	20.00	20.00
High-Retention	10	20.00	30.00	30.00	20.00
Medium					
Low-Retention	9	33.33	33.33	11.11	22.22
High-Retention	8	25.00	25.00	25.00	25.00
Large					
Low-Retention	10	20.00	30.00	30.00	20.00
High-Retention	8	37.50	12.50	37.50	12.50
Low MSEP					
Low-Retention	13	23.08	30.77	23.08	23.08
High-Retention	16	31.25	25.00	18.75	25.00
High MSEP					
Low-Retention	11	27.27	36.36	18.18	18.18
High-Retention	10	20.00	30.00	30.00	20.00

Note. The sum of percent occurrences for each school context and status type equals 100.00.

Table 4.16 displays quartile rank score distributions for retention strategy factor Autonomy and Access in Low-Retention and High-Retention schools by size and MSEP. Results indicate that sample schools regardless of retention status or school context had similar rank score distributions.

Table 4.16
Distributions of quartile rank scores based on Autonomy and Access Score in Low- and High-Retention schools by size and minority student enrollment proportion

		Percentages of Occurrence of Strategy Score by Quartile Rank			
Schools	n	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Small					
Low-Retention	5	20.00	40.00	20.00	20.00
High-Retention	10	40.00	10.00	30.00	20.00
Medium					
Low-Retention	9	44.44	22.22	11.11	22.22
High-Retention	8	25.00	37.50	12.50	25.00
Large					
Low-Retention	10	20.00	30.00	30.00	20.00
High-Retention	8	25.00	37.50	12.50	25.00
Low MSEP					
Low-Retention	13	23.08	30.78	30.78	15.38
High-Retention	16	43.75	18.75	12.50	25.00
High MSEP					
Low-Retention	11	36.36	18.18	27.27	18.18
High-Retention	10	20.00	30.00	10.00	40.00

Note. The sum of percent occurrences for each school context and status type equals 100.00.

Table 4.17 compares quartile rank score distributions for retention strategy factor Staff Relationships in Low-Retention and High- Retention schools by size and MSEP. Both Small-sized and Large-sized schools had similar distributions of rank scores regardless of retention status. Medium-sized High-Retention schools, however, had higher percentages of rank scores in the lower quartiles (i.e., 1st and 2nd quartiles) in contrast to respective Low-Retention schools.

In the context of MSEP, similar patterns of rank scores were observed in both Low MSEP schools and High MSEP schools regardless of retention status.

Table 4.17
Distributions of quartile rank scores based on Staff Relationships Score in Low- and High-Retention schools by size and minority student enrollment proportion

		Percentages of Occurrence of Strategy Score by Quartile Rank			
Schools	n	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Small					
Low-Retention	5	20.00	60.00	0.00	20.00
High-Retention	10	20.00	50.00	10.00	20.00
Medium					
Low-Retention	9	44.44	11.11	33.33	11.11
High-Retention	8	25.00	50.00	12.50	12.50
Large					
Low-Retention	10	20.00	30.00	30.00	20.00
High-Retention	8	25.00	25.00	25.00	25.00
Low MSEP					
Low-Retention	13	23.08	38.46	15.38	23.08
High-Retention	16	31.25	37.50	6.25	25.00
High MSEP					
Low-Retention	11	27.27	27.27	27.27	18.18
High-Retention	10	40.00	20.00	10.00	30.00

Note. The sum of percent occurrences for each school context and status type equals 100.00.

Table 4.18 displays results of quartile rank score distributions for retention strategy factor Appreciation in Low-Retention and High-Retention schools by size and MSEP. Medium-sized schools showed different patterns in rank scores, with High-Retention schools having higher percentages of scores in the upper quartiles in contrast to Low-Retention schools. Both Small-sized schools and Large-sized schools, however, had similar rank scores patterns regardless of retention status.

Results in the context of MSEP reveal that Low MSEP High-Retention schools had higher percentages of ranks scores in the upper quartiles compared to respective

Low-Retention schools. Regardless of retention status, no differences in Appreciation scores distributions were noted among High MSEP schools.

Table 4.18
Distributions of quartile rank scores based on Appreciation Score in Low- and High-Retention schools by size and minority student enrollment proportion

		Percentages of Occurrence of Strategy Score by Quartile Rank			
Schools	n	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Small					
Low-Retention	5	40.00	20.00	20.00	20.00
High-Retention	10	50.00	0.00	30.00	20.00
Medium					
Low-Retention	9	22.22	44.44	33.33	0.00
High-Retention	8	50.00	0.00	25.00	25.00
Large					
Low-Retention	10	30.00	20.00	40.00	10.00
High-Retention	8	25.00	25.00	25.00	25.00
Low MSEP					
Low-Retention	13	30.77	38.46	7.69	23.08
High-Retention	16	43.75	6.25	25.00	25.00
High MSEP					
Low-Retention	11	36.36	27.27	18.18	18.18
High-Retention	10	20.00	30.00	40.00	10.00

Note. The sum of percent occurrences for each school context and status type equals 100.00.

Table 4.19 displays quartile rank score distributions for retention strategy factor Collaboration Among Staff in Low-Retention and High-Retention schools by size and MSEP. Results indicate that sample schools regardless of retention status or school context had similar rank score patterns.

Table 4.19
Distributions of quartile rank scores based on Collaboration Among Staff Score in Low- and High- Retention schools by size and minority student enrollment proportion

		Percentages of Occurrence of Strategy Score by Quartile Rank			
Schools	n	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Small					
Low-Retention	5	20.00	60.00	20.00	0.00
High-Retention	10	20.00	40.00	20.00	20.00
Medium					
Low-Retention	9	11.11	66.66	22.22	0.00
High-Retention	8	50.00	12.50	12.50	25.00
Large					
Low-Retention	10	40.00	20.00	20.00	20.00
High-Retention	8	25.00	25.00	37.50	12.50
Low MSEP					
Low-Retention	13	23.08	38.46	15.38	23.08
High-Retention	16	18.75	37.50	25.00	18.75
High MSEP					
Low-Retention	11	36.36	18.18	27.27	18.18
High-Retention	10	50.00	0.00	40.00	10.00

Note. Sum of quartiles ranks for each school context and status type equal 100.00.

Table 4.20 presents a summary of results for retention strategy score distributions in Low- and High-Retention schools by school context. Results indicate Medium-sized High-Retention schools had higher percentages of rank scores in the lower quartiles for Staff Relationships. Additionally, Medium-sized High-Retention schools had higher percentages of rank scores in the upper quartiles for Total Retention Strategy Score and Appreciation, respectively. Rank score distributions in Low MSEP High-Retention schools also had higher percentages of rank scores in the upper quartiles for

Table 4.20

Summary results for distributions of quartile rank scores based on retention strategies in Low- and High-Retention schools by size and minority student enrollment proportion

		Percentages of Occurrence of Strategy Score by Quartile Rank									
Schools	n	Total Retention Strategy Score		Autonomy and Access		Staff Relationships		Appreciation		Collaboration Among Staff	
		LQ	UQ	LQ	UQ	LQ	UQ	LQ	UQ	LQ	UQ
Small											
Low-Retention	5	60.00	40.00	60.00	40.00	80.00	20.00	60.00	40.00	80.00	20.00
High-Retention	10	50.00	50.00	50.00	50.00	70.00	30.00	50.00	50.00	60.00	40.00
Medium											
Low-Retention	9	66.66	33.33	66.66	33.33	55.56	44.44	66.66	33.33	77.77	22.22
High-Retention	8	50.00	50.00	62.50	37.50	75.00	25.00	50.00	50.00	62.50	37.50
Large											
Low-Retention	10	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00	60.00	40.00
High-Retention	8	50.00	50.00	62.50	37.50	50.00	50.00	50.00	50.00	50.00	50.00
Low MSEP											
Low-Retention	13	53.85	46.16	53.85	46.16	61.54	38.46	69.23	30.77	61.54	38.46
High-Retention	16	56.25	43.75	62.50	37.50	68.75	31.25	50.00	50.00	56.25	43.75
High MSEP											
Low-Retention	11	63.63	36.36	54.54	45.46	54.54	45.46	63.63	36.36	54.54	45.46
High-Retention	10	50.00	50.00	50.00	50.00	60.00	40.00	50.00	50.00	50.00	50.00

Note. LQ = lower quartiles, i.e., 1st and 2nd quartiles; UQ = upper quartiles, i.e., 3rd and 4th quartiles. The sum of percent occurrences for each school context and status type equals 100.00.

Appreciation. No differences in rank score patterns were observed for neither Autonomy and Access, nor Collaboration Among Staff. In addition, no relationships were observed between retention strategy variables and retention status in neither Small-sized, Large-sized, nor High MSEP schools.

Types and Distribution of Retention Challenges

Verbal analysis of high school principal interviews identified 33 reported retention challenges that were experienced across sample schools to retain science teachers in the 2007-2008 academic year. Figure 4.5 shows frequencies of occurrence and applied weights for challenge items on the retention challenge scoring rubric. Five challenge categories that were identified during data analysis of interview transcripts included: (1) Career Changes, Advancement, and Improved Opportunities in Science Teaching; (2) Personal and Community Characteristics; (3) Work Environment; (4) Consequences and Costs of Turnover; and (5) Other Factors Facilitating Retention Challenges.

The majority of challenges (64.0%) were classified into Work Environment (n = 14) and Career Changes, Advancement, and Improved Opportunities in Science Teaching categories (n = 7; see Figure 4.6). *Provision of noncompetitive salary* was the

Career Changes, Advancement, & Improved Opportunities in Science Teaching (1)							**Personal & Community Characteristics (4)**				
Promotions & Out of Science Teaching Opportunities				Actions & Provisions by Competitive School Districts							
Graduate/Professional school (1)	Coaching positions (2)	Transition to administrative position (1)	Science industry employment (2)	Stealing science teachers (1)	Reduction in preps & course load (1)	Science-specific stipends & bonuses (3)	Health & personal family issues (3)	Spouse relocation (3)	Incompatibility/ dissatisfaction with teaching (2)	Low desire to live in community (2)	Gas & travel issues (1)
2	6	4	7	2	2	3	6	3	4	4	7

Work Environment (1)													
Work Load			Materials & Facilities		Student Characteristics		Inadequate Compensation		Lack of Support			State level Influences	
Extra duties & roles (1)	Number of preps & classes (1)	Time commitment & constraints (2)	Limited lab space (2)	Inadequate/outdated budgets, supplies & technology (2)	Student discipline issues (1)	Diversity & culture differences (2)	Provision of noncompetitive retirement salary (1)	Provision of noncompetitive salary (2)	Lack of new teacher support (2)	Dissonance between teacher needs & district supports (3)	Need improvements in staff relationships & appreciation (1)	Accountability pressure, i.e. TEKS (1)	4x4 Legislation & certification requirements (2)
2	3	3	2	2	3	5	3	13	7	3	2	3	4

Consequences & Costs of Turnover (2)				**Other Factors Facilitating Retention Challenges (3)**		
Supply & Demand		Costs of Attrition				
Retirement & replacement of experienced teachers (1)	Retirement & replacement of experienced science teachers (1)	Impact on student learning (2)	Time, monetary, & training expenditures on teacher (3)	Downsizing/School closure (1)	Timing of departure, e.g., mid-semester (3)	History of turnover (2)
8	3	2	5	4	4	6

Note. Weights appear in parentheses after main category and individual retention challenges. Frequencies appear in the same column of the individual challenges.

Figure 4.5 Retention challenge scoring rubric based on verbal analysis of high school principal interview responses.

most frequently reported retention challenge, occurring in thirteen of the 50 sample schools (26.0%), followed by *retirement and replacement of experienced teachers* which occurred in eight of the 50 sample schools (16.0%), respectively. Of the six reported retention challenges specific for the retention of science teachers: *science industry employment*; *stealing science* teachers; *science-specific stipends and bonuses*; *limited lab space*; *4X4 Legislation and certification requirements*; and *retirement and replacement of experienced science teachers*; *science industry employment* was the most frequently experienced challenge occurring in seven of the 50 sample schools (14.0%).[4]

Table 4.21 shows the types and distributions of reported retention challenges based on size and minority student enrollment proportion (MSEP). The mean total retention challenge score for all 50 sample schools was 9.7 with a standard deviation of about 10.6. The total retention challenges score range of 0.0 to 43.0 for sample schools fell below 110.0, the highest score a sample school could receive (data not shown).

[4]Note: 4X4 Legislation refers to the requirement that beginning with the 2010-2011 graduating class, all students attending Texas public schools are required to take four years of high school science (TEA, 2010a).

Mean score statistics also revealed low total score and main category scores for all 50 sample schools regardless of school context. Personal and Community Characteristics had the highest mean score across all school contexts with the exception of Large-sized and Very High MSEP schools. Work Environment and Other Factors Facilitating Retention Challenges categories received the highest score for Large-sized and Very High MSEP schools, respectively. Career Changes, Advancement, and Improved Opportunities in Science Teaching, however, received the lowest mean score across all school contexts with the exception of Large-sized and Low MSEP schools. Other Factors Facilitating Retention Challenges and Consequences and Costs of Turnover categories received the lowest mean score for Large-sized and Low MSEP schools, respectively. Taking standard deviations into account, no notable differences were observed between retention challenge scores for sample schools. This observation was irrespective of school context.

Table 4.21

Types and distribution of rubric retention challenges by size and minority student enrollment proportion

		Retention Rubric Challenge Categories											
		Career Changes, Advancement, and Improved Opportunities in Science Teaching		Personal and Community Characteristics		Work Environment		Consequences and Costs of Turnover		Other Factors Facilitating Retention Challenges		Total Challenge Score	
Schools	n	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
All Schools	50	0.90	1.34	4.00	7.32	1.94	2.47	1.20	2.32	1.68	3.33	9.72	10.61
School Size													
Small	15	0.60	0.91	6.13	9.54	1.33	2.22	0.80	1.82	1.60	2.75	10.47	10.18
Medium	17	1.24	1.35	4.94	7.68	2.29	2.95	1.65	2.76	2.82	4.43	12.94	13.95
Large	18	0.83	1.62	1.33	3.36	2.11	2.19	1.11	2.30	0.67	2.20	6.06	5.56
Minority Student Enrollment Proportion													
Very Low	21	0.76	1.14	4.95	8.29	1.86	2.76	1.24	2.23	1.43	2.62	10.24	10.23
Low	8	1.50	2.07	2.50	4.75	1.38	2.06	0.00	0.00	0.75	2.12	6.12	5.57
High	9	0.56	1.13	4.89	9.75	1.56	2.35	0.89	2.67	1.00	2.12	8.89	14.28
Very High	12	1.00	1.28	2.67	4.92	2.75	2.34	2.17	2.76	3.25	5.19	11.83	11.30

Note. M = Mean; SD = Standard Deviation. Highest possible weighted score based on the retention challenge scoring rubric was 110.00. Score range of weighted total retention challenges for sample schools was 0.00 to 43.00.

Relationships among Retention Challenges and Science Teacher Retention

Analyses using two simple linear regressions models and a multiple linear regression model were also conducted to determine relationships between retention challenges and retention rates of high school science teachers. There was a weak indirect relationship between weighted Total Retention Challenges Score and teacher retention rates. Table 4.22 and Figure 4.6 show this relationship was not statistically significant (p-value of 0.102). According to Table 4.23, weighted total retention challenges predicted in the simple linear regression model predicted only 5.0% of the variance of retention rates. A simple linear regression model of weighted most frequent retention challenge score and teacher retention rates produced similar results (data not shown).

Table 4.22
Regression coefficient for simple linear regression model describing retention rates of high school science teachers using weighted Total Retention Challenge Score

	Unstandardized Coefficients		Standardized Coefficients	t-value	Sig.
	B	SE	Beta		
Constant	0.000	0.139		0.000	1.000
Total Retention Challenge Score	-0.234	0.140	-0.234	-1.668	0.102

Note. SE = Standard Error.

Table 4.23
ANOVA values for simple linear regression model describing retention rates of high school science teacher using weighted Total Retention Challenge Score

	Sum of Squares	df	Mean Square	F ratio	Sig.
Regression	2.684	1	2.684	2.782	0.102
Residual	46.316	48	0.965		
Total	49.000	49			

Note. df = degrees of freedom.

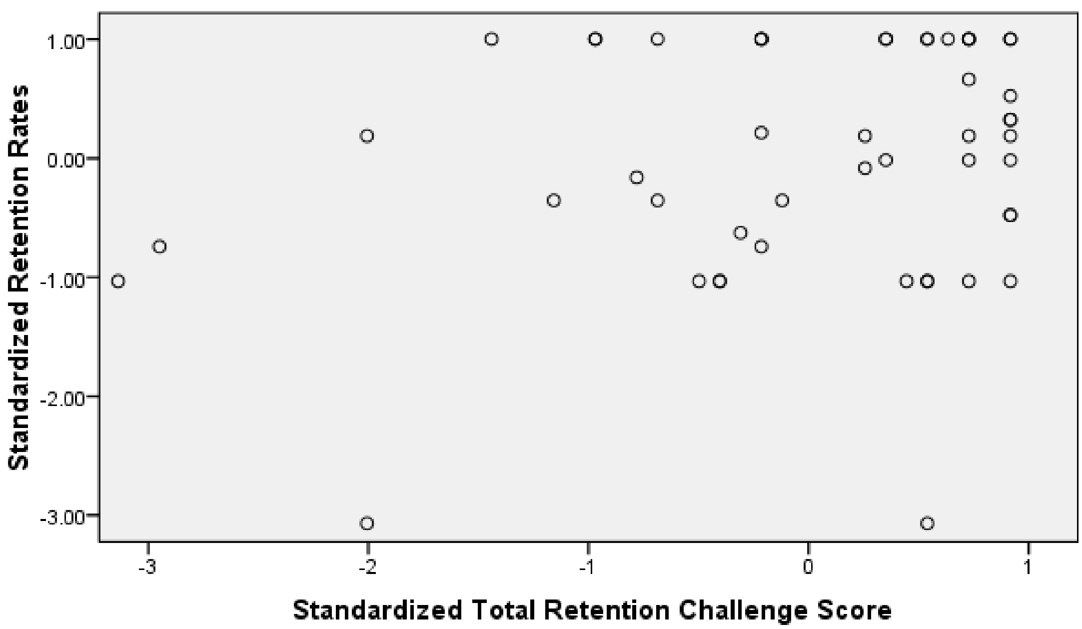

Figure 4.6 Scatter plot of retention rates of high school science teachers predicted by weighted Total Retention Challenge Score.

Table 4.24 and Figure 4.7 show the multiple linear regression model that was used to analyze the relationship between retention challenges factors and teacher retention. Challenge factors had either no relationship (i.e., Teacher Certification and Training Issues and Employment Opportunities Within Education), or a weak indirect relationships (i.e., Personal Circumstances and Community Characteristics) to retention rates. Employment Opportunities Outside Education was the only factor that had a direct, statistically significant relationship to teacher retention (p value equal to 0.018). Table 4.25 shows the amount of variance in retention rates explained between retention challenge factors was 15.0%, experiencing an increase from the simple linear regression models shown in Tables 4.22 and 4.23.

Table 4.24
Regression coefficient for multiple linear regression model describing retention rates of high school science teachers using retention challenge factors derived from factor analysis

	Unstandardized Coefficients		Standardized Coefficients	t-value	Sig.
	B	SE	Beta		
Constant	0.00	0.137		0.000	1.000
Personal Circumstances	-0.154	0.139	-0.154	-1.109	0.274
Teacher Certification and Training Issues	0.024	0.139	0.024	0.170	0.866
Community Characteristics	-0.112	0.139	-0.112	-0.809	0.423
Employment Opportunities Outside Education	0.340	0.139	0.340	2.446	0.018*
Employment Opportunities Within Education	0.011	0.139	0.011	0.080	0.937

Note. SE = Standard Error; *$p < .05$.

Table 4.25
ANOVA values for multiple linear regression model describing teacher retention using retention challenge factors

	Sum of Squares	df	Mean Square	F ratio	Sig.
Regression	7.461	5	1.581	1.581	0.185
Residual	41.539	44	0.944		
Total	49.000	49			

Note. df = degrees of freedom.

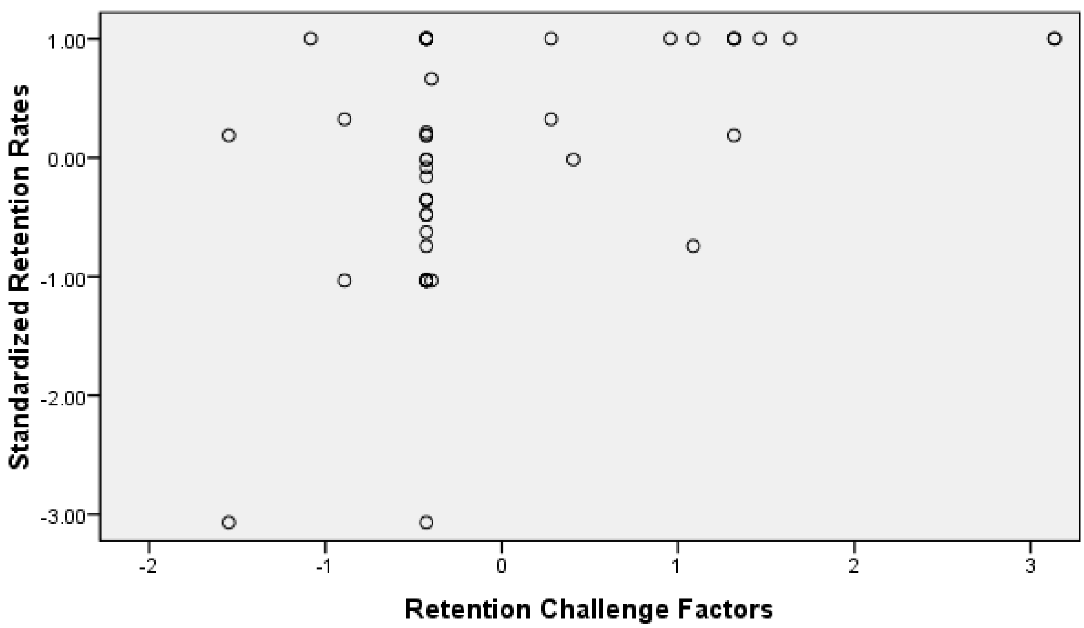

Figure 4.7 Scatter plot of retention rates of high school science teachers predicted by five retention challenges factors.

Relationships of Retention Challenges and Teacher Retention by School Context

Table 4.26 compares quartile rank score distributions for weighted Total Retention Challenge Score in High- and Low- Retention schools based on size and minority student enrollment proportion (MSEP). Results indicate that regardless of size and MSEP, there were no differences in rank score distributions between High- and Low- Retention schools.

Table 4.26

Distributions of quartile rank scores based on Total Retention Challenge Score in Low- and High-Retention schools by size and minority student enrollment proportion

		Percentages of Occurrence of Challenge Score by Quartile Rank			
Schools	n	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Small					
Low-Retention	5	20.00	40.00	20.00	20.00
High-Retention	10	30.00	20.00	40.00	10.00
Medium					
Low-Retention	9	33.33	22.22	22.22	22.22
High-Retention	8	25.00	25.00	25.00	25.00
Large					
Low-Retention	10	30.00	20.00	20.00	30.00
High-Retention	8	25.00	25.00	25.00	25.00
Low MSEP					
Low-Retention	13	23.08	23.08	30.77	23.08
High-Retention	16	37.50	18.75	25.00	18.75
High MSEP					
Low-Retention	11	27.27	27.27	27.27	18.18
High-Retention	10	30.00	20.00	30.00	20.00

Note. The sum of percent occurrences for each school context and status type equals 100.00.

Table 4.27 displays quartile rank score distributions for retention challenge factor Personal Circumstances in High-Retention and Low-Retention schools by size and MSEP. Results indicate that Medium-sized High-Retention schools had higher percentages of rank scores in the lower quartiles (i.e., 1st and 2nd quartiles) in contrast to Low-Retention schools. However, Large-sized High Retention schools had higher percentages of rank scores in the upper quartiles (i.e., 3rd and 4th quartiles). Small-sized schools, however, had similar patterns in rank scores regardless of retention status.

Table 4.27
Distributions of quartile rank scores based on Personal Circumstances Score in Low- and High-Retention schools by size and minority student enrollment proportion

		Percentages of Occurrence of Challenge Score by Quartile Rank			
Schools	n	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Small					
Low-Retention	5	60.00	0.00	20.00	20.00
High-Retention	10	20.00	40.00	20.00	20.00
Medium					
Low-Retention	9	55.56	0.00	22.22	22.22
High-Retention	8	75.00	0.00	12.50	12.50
Large					
Low-Retention	10	20.00	70.00	0.00	10.00
High-Retention	8	62.50	0.00	25.00	12.50
Low MSEP					
Low-Retention	13	76.92	0.00	0.00	23.08
High-Retention	16	6.25	56.25	0.00	37.50
High MSEP					
Low-Retention	11	63.64	0.00	9.09	18.18
High-Retention	10	20.00	50.00	0.00	30.00

Note. The sum of percent occurrences for each school context and status type equals 100.00.

In the context of MSEP, similar patterns of rank scores were observed in both Low MSEP and High MSEP schools regardless of retention status.

Table 4.28 compares quartile rank score distributions for retention challenge factor Teacher Certification and Training Issues in High-Retention and Low-Retention schools by size and MSEP. Results indicate Large-sized High-Retention schools had higher percentages of scores in the lower quartiles in contrast to Low-Retention schools. Small-sized and Medium-sized schools, however, had similar score patterns regardless of retention status.

Table 4.28
Distributions of quartile rank scores based on Teacher Certification and Training Issues Score in Low- and High- Retention schools by size and minority student enrollment proportion

		Percentages of Occurrence of Challenge Score by Quartile Rank			
Schools	n	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Small					
Low-Retention	5	20.00	80.00	0.00	0.00
High-Retention	10	30.00	50.00	0.00	20.00
Medium					
Low-Retention	9	22.22	55.56	0.00	22.22
High-Retention	8	25.00	62.50	0.00	12.50
Large					
Low-Retention	10	70.00	0.00	10.00	20.00
High-Retention	8	25.00	62.50	0.00	12.50
Low MSEP					
Low-Retention	13	23.08	61.54	0.00	15.38
High-Retention	16	25.00	56.25	0.00	18.75
High MSEP					
Low-Retention	11	72.73	0.00	9.09	18.18
High-Retention	10	30.00	60.00	0.00	10.00

Note. The sum of percent occurrences for each school context and status type equals 100.00.

Pertaining to MSEP, regardless of retention status no differences in ranks score patterns were noted for Low MSEP schools. High MSEP High-Retention schools, however, had higher percentages of rank scores in the lower quartiles in contrast to respective Low-Retention schools.

Table 4.29
Distributions of quartile rank scores based on Community Characteristics Score in Low- and High-Retention schools by size and minority student enrollment proportion

		Percentages of Occurrence of Challenge Score by Quartile Rank			
Schools	n	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Small					
Low-Retention	5	60.00	0.00	20.00	20.00
High-Retention	10	50.00	0.00	30.00	20.00
Medium					
Low-Retention	9	22.22	66.67	0.00	11.11
High-Retention	8	62.50	0.00	12.50	25.00
Large					
Low-Retention	10	80.00	0.00	0.00	20.00
High-Retention	8	25.00	62.50	0.00	12.50
Low MSEP					
Low-Retention	13	69.23	0.00	7.69	23.08
High-Retention	16	25.00	56.25	0.00	18.75
High MSEP					
Low-Retention	11	27.27	63.64	0.00	9.09
High-Retention	10	60.00	0.00	20.00	20.00

Note. The sum of percent occurrences for each school context and status type equals 100.00.

Tables 4.29 compares quartile rank score distributions for retention challenge factor Community Characteristics in High-Retention and Low-Retention schools by size and MSEP. Results indicate that both Medium-sized and High MSEP High-Retention schools had higher percentages of rank scores in the upper quartiles in contrast to Low-Retention schools. Small-sized, Large-sized, and Low MSEP, however, had similar patterns in rank scores regardless of High- or Low- Retention status.

Table 4.30 compares quartile rank score distributions for retention challenge factor Employment Opportunities Outside of Education in High-Retention and Low-Retention schools by size and MSEP. Results indicate that both Small-sized and Medium sized High-Retention schools had higher percentages of rank scores in the upper quartiles in contrast to Low-Retention schools. Higher percentages of Large-sized High-Retention schools, however, had scores ranked in the lower quartiles.

With respect to MSEP, results show that High MSEP High-Retention schools had higher percentages of quartile rank scores in the upper quartiles in contrast to Low-Retention schools. Low MSEP High-Retention schools had similar score patterns regardless of retention status.

Table 4.30
Distributions of quartile rank scores based on Employment Opportunities Outside of Education Score in Low- and High-Retention schools by size and minority student enrollment proportion

		Percentages of Occurrence of Challenge Score by Quartile Rank			
Schools	n	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Small					
Low-Retention	5	100.00	0.00	0.00	0.00
High-Retention	10	50.00	0.00	40.00	10.00
Medium					
Low-Retention	9	22.22	77.78	0.00	0.00
High-Retention	8	75.00	0.00	0.00	25.00
Large					
Low-Retention	10	70.00	0.00	10.00	20.00
High-Retention	8	25.00	62.50	0.00	12.50
Low MSEP					
Low-Retention	13	23.08	61.54	0.00	15.38
High-Retention	16	75.00	0.00	0.00	25.00
High MSEP					
Low-Retention	11	27.27	63.64	0.00	9.09
High-Retention	10	60.00	0.00	20.00	20.00

Note. The sum of percent occurrences for each school context and status type equals 100.00.

Table 4.31 compares quartile rank score distributions for retention challenge factor Employment Opportunities Within Education in High-Retention and Low-Retention schools by size and MSEP. Results indicate that regardless MSEP, there were no differences in rank score patterns between High- and Low- Retention schools. Results show that Small-sized High Retention schools where higher percentages of rank scores were observed in the upper quartiles in contrast to Low-Retention schools.

Large-sized High Retention schools, however, had higher percentages of scores ranked in the lower quartiles.

Table 4.31
Distributions of quartile rank scores based on Employment Opportunities Within Education Score in Low- and High- Retention schools by size and minority student enrollment proportion

		Percentages of Occurrence of Challenge Score by Quartile Rank			
Schools	n	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Small					
Low-Retention	5	40.00	60.00	0.00	0.00
High-Retention	10	20.00	50.00	10.00	20.00
Medium					
Low-Retention	9	22.22	66.67	0.00	11.11
High-Retention	8	25.00	62.50	0.00	12.50
Large					
Low-Retention	10	70.00	0.00	10.00	20.00
High-Retention	8	25.00	62.50	0.00	12.50
Low MSEP					
Low-Retention	13	76.92	0.00	0.00	23.08
High-Retention	16	25.00	56.25	0.00	18.75
High MSEP					
Low-Retention	11	27.27	63.64	0.00	9.09
High-Retention	10	20.00	60.00	0.00	20.00

Note. The sum of percent occurrences for each school context and status type equals 100.00.

Table 4.32 presents a summary of the quartile rank score distributions for retention challenges in Low- and High-Retention schools by school size and MSEP. Results indicate Medium-sized High-Retention schools had higher percentages of scores ranked in the lower quartiles for Personal Circumstances. However, Large-sized High-Retention schools had higher percentages of scores ranked in the upper quartiles for this particular challenge. Higher percentages of both Large-sized and High MSEP High-Retention schools had scores ranked in the lower quartiles for Teacher Certification and Training Issues in contrast to respective Low-Retention schools. Both Medium-sized and

High MSEP High-Retention schools had higher percentages of both Community Characteristics and Employment Opportunities Outside Education scores ranked in the upper quartiles in contrast to Low-Retention schools. Higher percentages of Small-sized schools also had scores based on Employment Opportunities Outside Education ranked in the upper quartiles compared to respective Low-Retention schools. Large-sized High Retention schools, however, had higher percentages of scores ranked in the lower quartiles for this particular challenge. While Small-sized High Retention schools had higher percentages of Education Opportunities Within Education scores ranked in the upper quartiles, Large-sized High Retention schools had higher percentages of scores ranked in the lower quartiles in contrast to respective Low- Retention schools. Regardless of school size or minority student enrollment proportion, no differences in score patterns were observed for Total Retention Strategy Score. In addition, no relationships between retention challenges and retention status were noted in Low MESP schools.

Table 4.32

Summary results for distributions of quartile rank scores based on retention challenges in Low- and High-Retention schools by size and minority student enrollment proportion.

School	n	Total Retention Challenge Score		Personal Circumstances		Teacher Certification and Training Issues		Community Characteristics		Employment Opportunities Outside Education		Employment Opportunities Within Education	
		Percentages of Occurrence of Challenge Score by Quartile Rank											
		LQ	UQ	LQ	UQ	LQ	UQ	LQ	UQ	LQ	UQ	LQ	UQ
Small													
Low-Retention	5	60.00	40.00	60.00	40.00	100.00	0.00	60.00	40.00	100.00	0.00	100.00	0.00
High-Retention	10	50.00	50.00	60.00	40.00	80.00	20.00	50.00	50.00	50.00	50.00	70.00	30.00
Medium													
Low-Retention	9	55.55	44.44	55.56	44.44	77.78	22.22	88.89	11.11	100.00	0.00	88.89	11.11
High-Retention	8	50.00	50.00	75.00	25.00	87.50	12.50	62.50	37.50	75.00	25.00	87.50	12.50
Large													
Low-Retention	10	50.00	50.00	90.00	10.00	70.00	30.00	80.00	20.00	70.00	30.00	70.00	30.00
High-Retention	8	50.00	50.00	62.50	37.50	87.50	12.50	87.50	12.50	87.50	12.50	87.50	12.50
Low MSEP													
Low-Retention	13	46.16	53.85	76.92	23.08	84.62	15.38	69.23	30.77	84.62	15.38	76.92	23.08
High-Retention	16	56.25	43.75	62.50	37.50	81.25	18.75	81.25	18.75	75.00	25.00	81.25	12.50
High MSEP													
Low-Retention	11	54.54	45.46	63.64	27.27	72.73	27.27	90.90	9.09	90.91	9.09	90.00	9.09
High-Retention	10	50.00	50.00	70.00	30.00	90.00	10.00	60.00	40.00	60.00	40.00	80.00	20.00

Note. LQ = lower quartiles, i.e., 1st and 2nd quartiles; UQ = upper quartiles, i.e., 3rd and 4th quartiles. *Note*. The sum of percent occurrences for each school context and status type equals 100.00.

Discussion

Teacher quality is an essential factor for preparing the next generation of scientists and science educators (NAS, 2007; NCEE, 1983; Richardson & Stuessy, 2010; Stuessy, 2009, p. 1). Review of the literature indicates that careful evaluation of the effectiveness of current retention strategies is paramount for improving retention of highly qualified teachers (Ingersoll & Perda, 2009). In addition, modification and development of retention strategies is equally informed by a comprehensive understanding of the challenges schools encounter to retain highly qualified teachers. This assertion is supported by prior research that indicates Texas high schools lose about one in four science teachers each year (Stuessy et al., 2009). For this study I used descriptive statistical analyses and regression models to examine relationships among school retention strategies, retention challenges, and high school science teacher retention. Specifically, study variables were analyzed to determine the types and distribution of retention strategies and retention challenges occurring across 50 sample high schools, as well as in the context of school size and minority student enrollment proportion (MSEP). Examining for similarities and variations in variable relationships by school context allowed me to present a more accurate representation of what is happening with retention of high school science teachers in Texas public schools.

Verbal analysis and descriptive statistics indicate occurrences of a broad range of retention strategies and retention challenges across Texas schools. Strategies and challenges tended to be general for all teachers, regardless of subject area taught. Sample schools tended to have similar mean statistic patterns across strategy categories identified by data analysis, regardless of school size and minority student enrollment proportion (MSEP). With respect to challenge categories identified in this study, variations in mean statistics patterns were identified between school contexts. Descriptive statistics also revealed low frequencies of occurrences, low mean statistics, and high standard deviations towards the lower end of score ranges for both strategies and challenges. Low mean strategy statistics indicate that "while Texas may exhibit a broad range of possible [retention strategies], most schools normally do not have a wide repertoire of [strategies]" (Stuessy et al., 2010, p. 30). Low mean challenge statistics, on the other hand, may indicate that either these schools were typically not confronted with numerous challenges to retain teachers, or that high school principals are not aware of the challenges that maybe contributing to teacher turnover at their schools.

Regression models revealed that school environmental variables had relatively no relationship with science teacher retention rates. Only one variable, Employment Opportunities Outside Education, had a statistically significant relationship to teacher retention. Specifically, this relationship indicates that schools concerned about losing teachers to science industry positions were more likely to implement strategies to address this particular challenge. This interpretation was supported by evidence that suggests High-Retention schools were more likely to identify and address challenges confronting their schools (Table 4.32). Explaining only three percent and fifteen percent of the variance in retention rates indicated multiple linear regression models contribute little to understanding the relationships between either retention strategies or retention challenges with high school science teacher retention, respectively. Similar conclusions were determined by the PRISE Research Group in a previous investigation about the roles of school- and teacher-level practices in science teacher retention (see Stuessy et al., 2010).

Descriptive statistical analysis of High- and Low-Retention schools, however, did reveal notable differences based on school size and MSEP. Three primary patterns were observed when comparing quartile rank distributions of both strategy and challenge scores between High- and Low-Retention schools. High-Retention schools either had (1) higher percentages of rank scores collectively in the 3rd and 4th quartiles (upper quartiles) in contrast to Low-Retention schools, (2) higher percentages of rank scores collectively in the 1st and 2nd quartiles (lower quartiles) in contrast to Low-Retention schools, or (3) similar patterns in rank scores to Low-Retention schools. Regarding the third pattern, principals at these schools are using either the same strategies or experiencing the same challenges regardless of school retention status for particular contexts (refer to Tables 4.20 and 4.32).

Regarding relationships rank strategy score distributions and retention status, the first pattern suggests that Low-Retention schools may need to increase the diversity and implementation of strategies to retain high school science teachers (Richardson & Stuessy, 2010). For example, findings indicate Medium-sized and Low MSEP High-Retention schools that express and show appreciation for teachers were more successful at retaining teachers in contrast to Low-Retention schools (Table 4.16). These results substantiate previous research that suggests teachers are more likely to stay longer in a school that supports, appreciations, and values their professional contributions (e.g., Harcombe et al., 1992).

With respect to retention challenges, higher percentages of rank scores in the upper quartiles for High-Retention schools indicated schools that perceive, for example, opportunities outside of education as contributing to teacher turnover were more likely to take measures to alleviate these challenges. Such measures appear to improve teacher retention in Small-sized, Medium-sized, and High MSEP schools. Low-Retention schools, however, either may not consider they were experiencing any challenges to retain science teachers, or were unable to pinpoint variables in the school environment that were contributing to teacher losses.

Concerning high percentages of strategy scores in the lower quartiles indicates that High-Retention schools use fewer strategies to retain high school science teachers in contrast to respective Low-Retention schools. For instance, findings indicate Medium-sized High-Retention schools were less likely than respective Low-Retention schools to promote strategies centered on relationships among staff and open door policies (see Table 4.19). This finding contradicts prior review of the literature that suggests professional interactions among science teachers and school administrators "are essential in creating a professional learning environment that supports teachers' continuous growth" and teacher retention (see Ivey & Richardson, 2007, p. 5). However, viewed from another standpoint one may conclude that while High-Retention schools use fewer strategies to retain teachers, these schools were more aware of the strategies *that work* in contrast to Low-Retention schools.

Regarding retention challenges, higher percentages of scores ranked in the lower quartiles for High-Retention indicated that these schools are not faced with specific challenges. This occurrence was noted to occur, for example, within Large-sized MSEP High-Retention schools that reported not experiencing many challenges specific to Employment Opportunities Outside Education. Despite awareness of this particular challenge, Large-sized MESP Low-Retention schools have not been able to successfully address this factor to reduce turnover of high school science teachers.

The findings from this study have various implications for policy and future research on teacher retention. First, findings suggest that (a) schools are not doing much in terms of developing robust strategic plans to retain teachers (i.e., both specific and non-specific to high school science) and (b) the retention strategies implemented at schools are not doing much to keep teachers. This observation was particularly noted among Small-sized and Large-sized schools that may be more focused on the development, retention, and graduation of high school students, and less focused on teacher development and retention.

The consequences of not developing strategic plans informed by scholarly research will become more pronounced as student enrollments continue to increase, baby boomers prepare to depart classrooms, and pre-retirement teachers continue to leave at outstanding rates outside the profession. High school principals need more support from both state and district-level administrators to develop and enforce robust strategic retention plans. Providing professional development opportunities to assist principals with the incorporation of retention strategies into a plan as well as other teacher professional continuum (TPC) practices (i.e., recruitment, induction, and professional development) occurring at their respective schools will provide a platform to improve retention of quality teachers. Initiatives such as providing recognition for schools that successfully retain teachers may also be a measure considered by the state to ensure stable, quality-learning environments for K through 12 students. In addition, principals may also consider conducting case studies at their schools to examine relationships between aspects of the school environment and teacher retention.

Second, findings suggest Low-Retention schools are not doing much to address challenges that lead to teacher losses. Principals that are unable to identify and address challenges at their schools will continue to experience turnover of quality teachers. Dialogue among district- and school-level administrators and teachers will be necessary to develop solutions to address retention challenges. Inclusion of these education stakeholders' ideas about retention challenges may also reduce dissonance regarding perceptions of the school environment (see Colley, 2003; SCETQ, 2004).

Third, with respect to statistical analysis, employing nonlinear models as opposed to linear models may be more useful in understanding the complex problem of science teacher retention (Stuessy et al., 2010). "[Although] statistical results do not extend beyond the boundaries of the state of Texas, the methods used by the [PRISE] Research Group are indeed generalizable to other states desiring to investigate the role [of retention strategies and retention challenges] associated with high levels of teacher retention" (Stuessy et al, 2010, p. 28).

The results reported in this study indicate that it may be worthwhile in future studies to explore relationships between school-level variables (i.e., strategies for recruitment, induction, professional development, and retention) and retention challenges based on the retention status of different school contexts. Results derived from these studies may inform education policy makers and education practioners about how retention challenges are being addressed in High-Retention schools. In addition, conducting case studies of schools that have a record of long term science teacher retention may provide a more comprehensive understanding about *how do we get there* in terms of retaining high school science teachers in Texas public schools.

Limitations

A few important limitations materialized during the implementation of this study. First, low numbers of retention strategies and retention challenges reported by high school principals rendered low retention scores for each respective rubric. Low retention scores presented a limitation for subsequent analytic methods (i.e., regression models and descriptive statistical analyses) used to examine relationships between strategies and challenges with science teacher retention. However, conducting factor analyses to identify strategies and challenges that explained the most variance in responses on rubrics minimized this limitation. Specifically, strategies and challenges emerging from factor analyses explained about 70.0% and 91.0% of the variance in respective rubrics responses.

Second, sample size presented a limitation for the interpretation of relationships between retention strategies (and retention challenges) and school retention status by school context. Specifically, small sample size and unequal numbers of High- and Low-Retention schools for each school context influenced both quartile rank score distributions and results interpretations. Therefore, result interpretations indicating similarities and differences in rank score distributions based on retention status by school context were very subjective. Considerations for future research would be to increase the sample size to sufficiently examine relationships among retention variables within different school contexts.

CHAPTER V

SCHOOL RETENTION STRATEGIES AND TEACHER JOB SATISFACTION: PREDICTING MOBILITY OF SCIENCE TEACHERS

Retention of high-quality teachers is a recurring theme in discussions regarding students' academic achievement (Stuessy et al., 2010). Both policy analysts and education stakeholders are well aware that the retention of highly qualified science teachers is essential for the preparation of future leaders in science and science education (AAAS, 1990; Carroll & Foster, 2010; Ingersoll & Perda, 2009; Levy et al., 2006; NAS, 2007; NCES, 2006). Unfortunately, the ability to improve the retention of highly qualified teachers has continued to evade both national-and state-level reform efforts.

A factor associated with teacher retention is teacher job satisfaction (Ingersoll, 2003; Weiqi, 2007). Evidence has suggested "teachers who are satisfied with their current teaching position are less likely to move to another school or leave the profession. Satisfied teachers are also likely to contribute to the professional culture of the school" (Bozeman & Stuessy, 2009, p.1).

In contrast, dissatisfaction among teachers may be an indication of a demoralized, passive school climate. Low job satisfaction levels may also indicate dissonance between teachers' perceptions and administrators' perceptions about conditions and practices within the school environment (Colley, 2003; SCETQ, 2004). Failure by administrators to recognize, acknowledge, and incorporate critical concerns identified by teachers into school policies may impede increases in satisfaction levels, teacher retention, and student achievement (Kearney, 2008; SECTQ, 2004). As such, understanding the dynamics between teachers' job satisfaction and school practices "can allow policymakers to (a) develop strategies for increasing teachers' levels of satisfaction with their working environments in order to increase teacher retention; and (b) make predictions regarding the likeliness of sustaining a workforce of highly qualified…teachers" (Bozeman & Stuessy, 2009, p.1). In an effort to build on current literature, this chapter explores the relationships among school retention strategies, teacher job satisfaction, and science teacher mobility. Teacher mobility is an inclusive term for employment outcomes associated with retention, migration, and attrition (Bozeman, 2010).

Related Literature

Characterizing Job Satisfaction

Several studies have suggested that a positive association exists between teacher job satisfaction and teacher retention (Ingersoll, 2001; Stockard & Lehman, 2004; Stuessy, 2007; Weiqi, 2007). While a review of the literature does not provide a universal definition for job satisfaction (e.g., Bozeman & Stuessy, 2009; Butt & Lance, 2005; Eick, 2002; Ingersoll 2001; Locke, 1969; Scott, Gravelle, Simoens, Bojke, & Sibbald, 2006; Stevenson et al., 1999; Stockard & Lehman, 2004; Vandenberg & Lance, 1992), one can reason that satisfaction levels are governed by cognitive, affective, and self-regulations processes (Huitt & Cain, 2005; Locke, 1969).

Job satisfaction represents the cognitive construct in this chapter, an important component of reciprocal determinism. Reciprocal determinism, as described in previous chapters, centers on the triadic interaction between cognitive, behavioral, and environmental variables (Bandura, 1977, 1978). In this chapter, I used reciprocal determinism as a theoretical framework to scaffold the investigation of study variables.

Sources of Satisfaction and Dissatisfaction

Sources of Satisfaction. Factors identified as sources of satisfaction have included working in a collegial and supportive environment, working with students, and working at a preferred grade level (Hean & Garrett, 2001; Huang & Fraser, 2009; Watson, 2006; Weiqi, 2007). Hean and Garrett's (2001) investigation observed that secondary science teachers derived much of their satisfaction from relationships with other teachers and students. Interestingly, this study also noted that as teachers aged they became less satisfied with student relationships and more satisfied with taking on the role of student developer (Hean & Garrett, 2001). Sources facilitating increases in job satisfaction were also linked to higher teacher retention outcomes (e.g., Butt & Lance, 2005; Huang & Fraser, 2009; Ingersoll, 2001; Skaalvik & Skaalvik, 2009; Stockard & Lehman, 2004). Teacher retention refers to teachers who remain to teach at a school from one year to the next.

Sources of Dissatisfaction. Conversely, sources of dissatisfaction have included student misbehavior, poor salary, poor facilities, time pressure and excessive workload (Bozeman & Stuessy, 2009; Butt & Lance, 2005; Hean & Garrett, 2001; Huang & Fraser, 2009; Klassen & Anderson, 2009; Skaalvik & Skaalvik; 2009; Weiqi, 2007). Time pressure and excessive workload was each designated as sources of dissatisfaction among teachers (Butt & Lance, 2005; Hean & Garrett, 2001; Huang & Fraser, 2009;

Klassen & Anderson, 2009; Skaalvik & Skaalvik; 2009). Dissatisfaction with laboratory facilities and available resources were particularly expressed by science teachers (Bozeman & Stuessy, 2009; Hongying, 2007; Watson, 2006). For instance, Texas high schools received a grade of "F" to reflect high school science teachers' low levels of satisfaction with science lab facilities and equipment at their schools (Bozeman & Stuessy, 2009). These sources of dissatisfaction may indicate, at best, mediocre working conditions within a school. Mediocre working conditions may either compromise student learning, the organizational commitment of teachers, or contribute to turnover (Bozeman, 2010; Kukla-Acevedo, 2009; Metty & Stuessy, 2007). Teacher turnover refers to individuals who either migrate to teach at another school or depart the teaching profession (also known as attrition; Ingersoll, 2001).

Associations with Demographic Variables

Variations in research findings suggest teacher demographic variables have weaker relationships with job satisfaction as opposed to teacher mobility (e.g., Hean & Garret, 2001; Huang & Fraser, 2009; Kearney, 2008; Klassen & Anderson, 2009; Stockerd & Lehman, 2004). For instance, Klassen and Anderson's (2009) study showed that student behavior, student attitudes, and more time needed for instruction were the top three sources of job dissatisfaction indicated by both male and female teachers. These findings supported previous research that suggested student behavior can influence teachers' morale, career choice commitment, and retention (Belfield, 2005; Weiss, 1999). Conversely, female teachers in the Huang and Fraser study (2009) indicated time pressure and excessive workload as sources of stress and dissatisfaction, whereas these concerns were less noted among male teachers. Pertaining to race and ethnicity, Kearney's (2008) study investigating factors affecting satisfaction and retention of teachers drew mixed conclusions.

Teacher Mobility

With respect to teacher mobility studies, the majority of evidence suggested that female teachers were more likely to leave the teaching profession than male teachers (Borman & Dowling, 2008; Grissmer et al., 1992; Guarino, et al., 2006; Ingersoll, 2001). Other trends in mobility studies revealed that (a) ethnic minority teachers were less likely to leave schools that have comparable ethnic student demographics, and (b) younger teachers in their first few years of teaching and older teachers after many years of teaching were more likely to depart the teaching profession (Borman & Dowling, 2008; Guarino et al., 2006; Haggstrom et al., 1988; Kirby & Grissmer, 1993; Scafidi et al., 2007). Discrepancies in evidence were apparent when subject area was taken into account. While some studies suggested that there were no differences between mobility decisions of science teachers and teachers of other subject areas (Ingersoll, 2001; NCES, 2008; TEA, 1995), other studies have shown that science teachers left the profession at higher rates (Ingersoll, 2006; Grissmer et al., 1992; Kirby & Grissmer, 1993).

Purpose of This Study

Deficiencies in research persist regarding relationships between science teachers' job satisfaction and school retention strategies. Furthermore, current research has yet to explore whether the interactions between these variables serve as indicators for teacher mobility behavior. The purpose of this study was to investigate the relationships between school retention strategies, teacher job satisfaction, and mobility outcomes of high school science teachers. Specifically, I provide evidence to answer the following research questions:

Research Question 1: What are the relationships between teacher job satisfaction and science teacher mobility?

Research Question 2: What are the relationships between school retention strategies and science teacher mobility?

Research Question 3: Are the interactions between school retention strategies and teacher job satisfaction predictors for science teacher mobility decisions?

Context of Study

This study was conducted in concurrence with the Policy Research Initiative in Science Education (PRISE) research study. This study sought to investigate the State-of-the-State of Texas high school science teacher professional continuum (TPC). "Conceptually,…the TPC refers to the professional lives of…teachers along the continuum of their recruitment, induction, renewal, and [retention] in the teaching profession" (Stuessy et al., 2010, p. 7). This five-year project, funded by the National Science Foundation (NSF), sought to answer three essential policy questions about the high school science TPC in Texas: *Where are we? Where do we want to go? How do we get there?*

Research Design

Consideration of data sources and potential implications of this study led me to adopt pragmatic philosophies to guide the methods for this investigation. Specifically, qualitative research methods introduced by Chi (1997) allowed me to gain an inductive understanding about retention strategies for teachers occurring within and across sample schools. *School* in this study refers to (a) Texas public schools that offer high school science courses, and (b) administrator and district policies and strategies implemented at the school level. Quantitative research methods such as survey design allowed me to assess science teacher satisfaction with various aspects of the school environment. Descriptive statistical analysis allowed me to deduce trends relative to science teacher mobility. A data transformation, triangulation mixed methods design, as described by Creswell and Clark (2007), served as the research design for this mixed methods study. The combination of these two approaches presents a rich picture regarding relationships between school- and teacher- level variables that were associated with mobility behavior of high school science teachers.

Methods

Sampling Plan

"The PRISE [school and] teacher samples were selected using a multistage, [modified] probability design" (Bozeman, 2010, p. 107; see also McNamara & Bozeman, 2007; Stuessy, 2009). The *first phase* of the sampling plan consisted of selecting 50 schools from the 1,333 public schools in Texas that offer high school science courses. Two explicit stratification variables, i.e., school size and minority student enrollment proportion (MSEP), were used simultaneously to create the representative sample. A third implicit stratification variable, geographic region, was also included to yield results that were representative to all Texas public high schools. Validity of the sample was verified by chi-square [analysis] (chi-square = 0.867, df = 11, p_{crit} = 19.675) to assure the sample was indeed representative of the entire population of schools in Texas (Stuessy, 2009). Seventy-eight percent of the 50 original schools randomly selected agreed to participate in the PRISE study (n = 39). Identification and replacement of non-participating schools were conducted with eleven schools that had similar sampling characteristics. Inclusion of the replacement schools yielded a 100 percent school participation rate.

The *second phase* of the sampling plan identified teachers in each of the 50 schools, who taught at least one high school science course. Random selection of teachers was not conducted in this phase as all science teachers from sample schools were selected as subjects. Participants from each of the sample schools included principals, science teacher liaisons, and high school science teachers. Table 5.1 displays frequencies and percentages of science teachers' participation rates based on random and replacement status of schools. Participants were asked for their written consent prior to their participation in the PRISE research study.

Table 5.1
Participation rates of the 50 sample schools and 385 high school science teachers in the PRISE research study

School Participation Status	Total Teacher Sample Frequency Counts	Teacher Participation Status Frequency Counts	Participation Rate of Teachers (%)
Random (n = 39)	316	280	88.6
Replacement (n = 11)	69	63	91.3
Total	385	343	89.2

Data Collection

Texas Poll for Secondary Science Teachers. Processes of "dialogue, item writing, pilot testing, reflection, and revision" (Bozeman & Stuessy, 2009, p. 2) resulted in the development of the Texas Poll of Secondary Science Teachers (TPSST). The TPSST questionnaires contained questions pertaining to the level of engagement in professional activities and job satisfaction of teachers. Appendix A provides the job satisfaction questions that were included on the TPSST. Responses to questions specific to job satisfaction were based on a four-point ordinal scale (4 = very satisfied, 3 = satisfied, 2 = dissatisfied, and 1 = very dissatisfied; Bozeman, 2010). Questionnaires were given to science teacher liaisons either face-to-face or by mail to sample schools for distribution to science teachers. Questionnaires were either returned via mail (postage provided by PRISE researchers) or picked up by a PRISE researcher. Non-respondents were either contacted by telephone or visited by a PRISE researcher at their respective sample school to complete and return questionnaires. Science teachers that returned a completed questionnaire received a $25.00 stipend. Overall return rates of the

TPSST reached 89.2%. Reponses to the TPSST were archived in the PRISE Teacher Database.

High School Principal Interviews. The PRISE Administrator Interview Protocol included questions about the recruitment, induction, renewal, and retention of high school science teachers. PRISE research fellows conducted interviews with high school principals of the 50 sample schools, thereby achieving a 100% participation rate. Table 5.2 displays interview questions specific to teacher retention. Interviews were conducted either face-to-face or over the telephone. Researchers recorded fieldnotes and/or audio-taped interviews. Acquired interviews were then transcribed, organized into data charts, and archived into the PRISE School Database. Archived interviews were also coded to protect the identity of the sample schools. Interviews with principals and archiving of data begin January 2008 and continued until September 2008.

High School Science Teachers. School master schedules and teacher lists were collected from the 50 sample schools in academic years 2007-2008 and 2008-2009 by PRISE researchers. This information was used to identify sample teachers, who taught high school science courses at their respective schools. To ensure confidentiality, codes were assigned to each identified science teacher prior to archival in the PRISE Teacher Database. In addition, the Public Education Information Management System (PEIMS), a division within the Texas Education Agency (TEA), was queried to obtain information about sample teachers’ course assignments and demographics.

Table 5.2
Retention questions from the PRISE Administrator Interview Protocol

Retention Questions[1]
• How does teacher retention work in your school?
• Explain your school's current teacher retention procedures.
• Identify "what works best" in your school's current teacher retention procedures.
• Do you see teacher retention issues or concerns that are likely to emerge in the immediate future at your school? (Elaborate these issues and concerns.)
• Do you have plans to change your school's current teacher retention process? (Elaborate these changes and how they might affect your retention efforts.)
• How might our network help you with teacher retention at your school? (Elaborate.)
• Is there anything else that you would like to tell us about retention at your school?
• Is there anything else that you would like to tell us about retention that you think would be helpful to share with the network and/or with the population of schools that teach high school science?

Note. [1]High school principals were asked to provide their perspectives about teacher retention both general for all subjects and specific to high school science.

Data Analysis

Science Teacher Job Satisfaction. Descriptive statistics were used to describe the composite job satisfaction score for each science teacher. Job satisfaction scores were based on "teachers' responses to fourteen questions on the Texas Poll [of Secondary Science Teachers questionnaire] about [their] satisfaction with various aspects of [the] professional environment" (Bozeman & Stuessy, 2009, p. 3). "Imputation of modal values for each non-responding teacher was used for the purpose of completing data analysis. Cronbach's alpha (a = 0.862) was calculated as a measure of internal consistency, supporting the researchers' claims that the instrument was reliable" (Bozeman & Stuessy, 2009, p. 3). Composite job satisfaction scores were computed and converted to z-scores to later examine relationships between continuous variables of this study on the same scale.

School Retention Strategies. I conducted verbal analysis on archived high school principal interviews to develop the retention strategy scoring rubric shown in Figure 5.1. Individual retention strategies included on the scoring rubric were identified within interview transcripts. At least two principals had to have reported using a particular strategy for it to be included on the rubric. A "tentative taxonomic categorical system" (Stuessy, 2010, p.7) was implemented to sort and organize 52 individual strategies into five main categories and nine sub-categories as shown on the rubric (Figure 5.1). "Inter-rater reliability was established for [the] resulting rubric between pairs of [peers] who evaluated the interviews from principals until the pair reached at least [85.0%] agreement" (Stuessy, 2010, p. 7).

Providing Individual Teacher Supports (3)														Marketing a Positive Local Community (1)				
Autonomy			Appreciation				Pecuniary Incentives											
Decision-making (2)	Ownership within classroom & science program (2)	Classroom placement is best fit for science teacher (2)	Staff appreciation (1)	Teacher recognition (2)	Social events (1)	Attendance awards (1)	Insurance (3)	Subsidizing benefits, i.e., relocation, housing & daycare (3)	Pay raises & loyalty pay (1)	Other monetary incentives (1)	Retirement programs (2)	Competitive salary (2)	Science-specific stipend (1)	Environment/Physical location (2)	Local economics (1)	Family ties (2)	Parental support (1)	Community support (1)
10	6	7	8	4	5	2	2	2	8	3	3	6	4	8	2	4	2	3

Marketing a Positive School Community (2)																		
Leadership			Administrative Support				Supportive & Safe		School Culture & Collegiality									
Presence of teacher leadership (1)	Presence of shared leadership (3)	Presence of administrative leadership (2)	Open-door policies (1)	Assist with student discipline (1)	Appeal to district for teachers' needs (1)	Comfortable teaching environment (2)	Safe teaching environment (1)	Supportive science department (1)	Collaboration among colleagues (1)	Treated as professionals (3)	Good academic reputation (1)	Recognized as having vital role to school (3)	Relationships with staff members (2)	Student-teacher relationships (3)	Good student reputation (1)	Care for teachers (1)	Sense of community (2)	Student-centered environment (2)
2	2	6	10	7	4	8	4	2	6	2	2	7	12	3	2	3	3	3

Marketing a Positive Work Environment (2)									Career Enhancements Practices (2)				
Work Load				Resources									
Alleviation of workload (1)	Provide planning time (3)	Class size (1)	Provide personal time (2)	Technology (1)	Science facilities (1)	Instructional materials (1)	Other nonspecific supplies (1)	Departmental funding (3)	Ongoing teacher assessment (2)	Termination of unsuccessful staff (1)	Recruitment practices (1)	Induction practices (2)	Professional development opportunities (2)
3	5	3	4	5	9	8	5	3	7	8	4	6	4

Note. Weights appear in parentheses after main category and individual retention strategies. Frequencies appear in the same column of the individual strategies.

Figure 5.1 Retention strategies scoring rubric based on verbal analysis of high school principal interview responses.

Schools received scores based on responses reported by high school principals. A factor analysis yielded the following four retention strategy factors: (1) Autonomy and Access, (2) Staff Relationships, (3) Appreciation, and (4) Collaboration Among Staff (see Table 5.3). Names of factors were based on commonalities shared between extracted retention strategies. Table 5.4 shows the retention strategy factors that explained approximately 70.0% of the variance in principal responses recorded on the scoring rubrics. Retention strategies were converted into z-score measurements by the Statistical Package for Social Sciences (SPSS) software version 16.0.

Table 5.3
Four principal factors reduced from factor analysis with Varimax Rotation of reported retention strategies

Individual Retention Strategies	Factors			
	1	2	3	4
This school provides teachers autonomy in decisions pertaining to school level and classroom level practices	0.769	-0.222	0.229	0.352
This school ensures teachers have access to non-specific supplies and resources	0.667	-0.205	0.383	-0.246
This school has presence of administrative leadership	-0.662	-0.333	-0.002	0.131
This school has good relationships among staff members	-0.047	0.788	-0.209	-0.023
This school has an open door policy for teachers	0.016	0.654	0.349	0.098
This school expresses and shows appreciation for teachers	-0.007	-0.018	0.851	-0.174
This school encourages collaboration among colleagues	-0.042	0.048	-0.161	0.924

Table 5.4
Variance explained by four principal factors reduced from factor analysis of individual retention strategies on the retention strategy scoring rubric

Factors and Retention Strategy Items[1]	Eigenvalue	Variance Explained (%)	Cumulative Variance Explained (%)
Autonomy and Access (items 1, 22, 46)	1.52	21.64	21.64
Staff Relationships (items 23, 33)	1.20	17.12	38.76
Appreciation (item 4)	1.17	16.76	55.52
Collaboration Among Staff (item 29)	1.00	14.34	69.86

Note. [1]Retention strategy item numbers are based on organization of the retention strategy scoring rubric.

Science Teacher Mobility. The mobility status of 385 high school science teachers was determined by triangulating school master schedules and teacher lists of the 2007-2008 and 2008-2009 academic years. "Names of science teachers retained from 2007-2008 to teach science in 2008-2009 [appeared] on both lists" (Stuessy et al., 2009, p. 2). These teachers were classified as *stayers*. Teachers no longer teaching at a school, but whose names were found in the state educator databases for the 2008-2009 school year were classified as migrating teachers or *movers* (Stuessy et al., 2009). Teachers who were neither identified on the master schedules and teacher lists nor found in the educator database for 2008-2009 were counted as *leavers* from the profession (Stuessy et al., 2009).

Table 5.5 displays frequency counts and percentages of 328 science teachers classified as either *stayers*, *movers*, or *leavers*. Fifty-seven teachers were excluded from this study because they were either 60 years of age or older (n = 33) or data were missing regarding their mobility status (n = 24). The former group was excluded from the study based on the reasoning that these science teachers were more likely to have invested more time at their current school and were nearing retirement, and therefore, more likely to stay at their school regardless of their satisfaction levels or school practices (e.g., Weiqi, 2007). This assumption was supported by previous results indicating that three out of four teachers 60 years of age or older leaving a sample school also departed the profession. Because some sample schools had one or two science teachers, exclusion of these older teachers reduced the school sample size from 50 to 47 schools. Results in Table 5.5 also show Texas high schools lose about one in four high school science teachers each year.

Table 5.5
Frequency distribution of high school science teachers classified as stayers, movers, and leavers (n = 328)

Mobility status	Frequency Count	Percentage (%)	Cumulative Percentage (%)
Stayer	254	77.4	77.4
Mover	39	11.9	89.3
Leaver	35	107	100.0
Total	328	100.0	

Multilevel Analysis. Four multi-level multinomial models were generated to investigate the relationships among science teacher mobility, science teacher job satisfaction, and school retention strategies. Table 5.6 shows the descriptive statistics computed for both teacher- and school-level data. Because of the nested nature of the data shown in Figure 5.2, multilevel modeling was deemed the most appropriate method to conduct analyses for this study (Lui, Lee, & Lin, 2010).

Table 5.6
Descriptive statistics for study variables

	Study Variables	n	M	SD	Minimum	Maximum
Level 1 (Teacher)	Mobility	328	2.67	0.66	1.00	3.00
	Job Satisfaction	328	-0.03	1.01	-3.18	2.22
Level 2 (School)	Autonomy & Access	47	0.01	1.03	-1.78	2.51
	Staff Relationships	47	0.00	1.02	-1.48	2.45
	Appreciation	47	-0.04	1.00	-1.97	3.11
	Collaboration Among Staff	47	0.03	1.02	-1.34	2.99

Note. M = Mean; SD= Standard deviation. Mobility is a categorical variable. Job satisfaction and retention strategies were converted to z-scores.

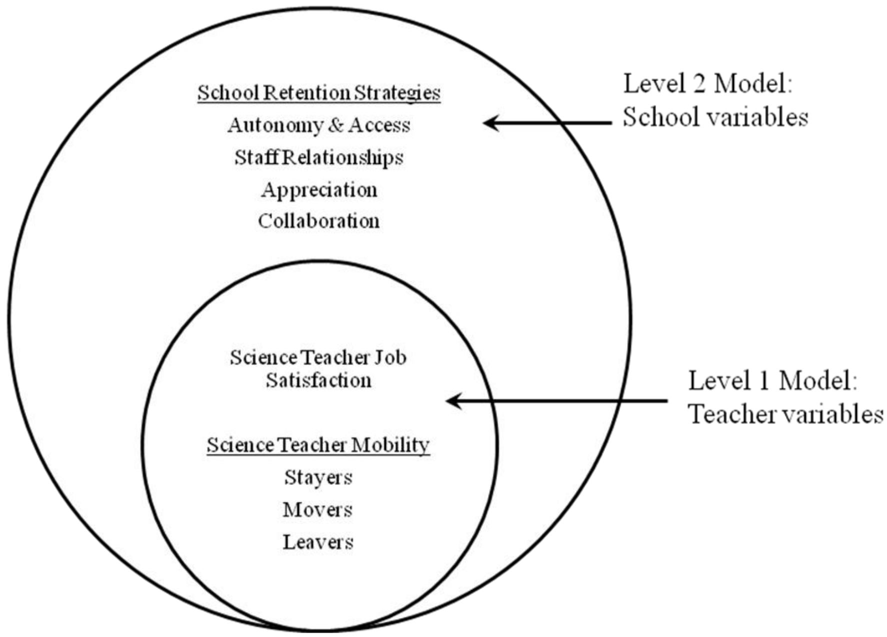

Figure 5.2 Schematic of a multilevel model examining the relationships among school retention strategies, science teacher job satisfaction, and science teacher mobility.

First Level Analyses

In the first level, science teacher mobility (the outcome measure of interest) was regressed on job satisfaction, a variable noted within the literature to have a positive relationship to teacher retention (Ingersoll, 2003; Weiqi, 2007). Equations 5.1 and 5.2 provide the models within each school that were expressed in this form:

$$Prob(Mobility_{ij} = 1|\beta_j) = \text{Leaver}\phi_{ij}$$

$$Prob(Mobility_{ij} = 1|\beta_j) = \text{Mover}\phi_{ij}$$

$$Prob(Mobility_{ij} = 1|\beta_j) = \text{Stayer}\phi_{ij} = 1 - \text{Leaver}\phi_{ij} - \text{Mover}\phi_{ij}$$

$$\log[P(\text{Leaver})/P(\text{Stayer})] = \beta_{0j(1)} + \beta_{1j(1)}\,(\text{Job Satisfaction})_{ij} + \varepsilon_i \qquad (5.1)$$

$$\log[P(\text{Mover})/P(\text{Stayer})] = \beta_{0j(2)} + \beta_{1j(2)}\,(\text{Job Satisfaction})_{ij} + \varepsilon_i \qquad (5.2)$$

where *i* subscripts individual teachers and *j* subscripts the sample school in which a teacher taught a high school science course. This analysis yielded separate sets of regression parameters for each school. β_{0j} represented the estimated intercept, β_{1j} represented the slope for the teacher level predictor variable job satisfaction, and ε_i referred to Level 1 residual variance (Willms, 1999).

With respect to coding, *Mobility* (a categorical variable) was coded as the following: *Leaver* 1, *Mover* 2, and *Stayer* 3. Stayer was the reference variable selected by the program to perform statistical analysis. Numbers in the parentheses following the intercepts and slopes (i.e., β_{0j} and β_{1j}) differentiate model probabilities computations of *leavers* and *movers* to the reference variable. As previously mentioned, teacher responses to fourteen question items specific to *job satisfaction* on the TPSTT were calculated as a continuous, composite variable for each teacher.

Second Level Analyses

Regression parameters from the first level of analysis became the outcome variables predicted in the Level 2 model between schools (Osborne, 2000; Raudenbush & Bryk, 1986). Outcome variables were regressed on the following continuous school-level predictor variables: Autonomy and Access, Staff Relationships, Appreciation, and Collaboration Among Staff. These four predictor variables were also retention strategy factors determined via factor analysis in the previous chapter. Equations 5.3 and 5.4 correspond to the equations for regression parameters that compared first and second level predictor relationships with *leavers* and *stayers* as indicated by subscript $_{(1)}$. Equations 5.5 and 5.6 correspond to parameters that measure science teachers who either move to teach at another school or stay at their current place of employment as indicated by subscript $_{(2)}$.

$$\beta_{0j} = \gamma_{00(1)} + \gamma_{01(1)}(\text{Autonomy and Access})_j + \gamma_{02(1)}(\text{Staff Relationships})_j + \gamma_{03(1)}(\text{Appreciation})_j + \gamma_{04(1)}(\text{Collaboration Among Staff})_j + U_{0j(1)} \tag{5.3}$$

$$\beta_{1j} = \gamma_{10(1)} + \gamma_{11(1)}(\text{Autonomy and Access})_j + \gamma_{12(1)}(\text{Staff Relationships})_j + \gamma_{013(1)}(\text{Appreciation})_j + \gamma_{14(1)}(\text{Collaboration Among Staff})_j + U_{1j(1)} \tag{5.4}$$

$$\beta_{0j} = \gamma_{00(1)} + \gamma_{01(2)}(\text{Autonomy and Access})_j + \gamma_{02(2)}(\text{Staff Relationships})_j + \gamma_{03(2)}(\text{Appreciation})_j + \gamma_{04(2)}(\text{Collaboration Among Staff})_j + U_{0j(2)} \tag{5.5}$$

$$\beta_{1j} = \gamma_{10(1)} + \gamma_{11(2)}(\text{Autonomy and Access})_j + \gamma_{12(2)}(\text{Staff Relationships})_j + \gamma_{013(2)}(\text{Appreciation})_j + \gamma_{14(2)}(\text{Collaboration Among Staff})_j + U_{1j(2)} \tag{5.6}$$

where γ_{00} corresponded to the Level 2 intercept; $\gamma_{01\ldots}\gamma_{04}$ corresponded to the slopes of school level predictor variables; γ_{10} corresponded to the interaction between Level 2 intercept with the Level 1 predictor variable (i.e., job satisfaction); $\gamma_{11}\ldots\gamma_{14}$ corresponded to the slopes of the interactions between retention strategies and job satisfaction; and U_{0j} and U_{1j} corresponded to the Level 2 residual variance. Equation 5.7 displays the mixed model, including interactions between job satisfaction and retention strategy variables, a focus for this study. Multilevel analyses were conducted using SPSS 16.0 and HLM V6.08 software.

$$Y(\text{Mobility})_{ij} = \gamma_{00(1)} + \gamma_{01(1)}(\text{Autonomy and Access})_{j} + \gamma_{10(1)}(\text{Job Satisfaction})_{ij} + \gamma_{11(1)}(\text{Autonomy and Access})_{j}{*}(\text{Job Satisfaction})_{ij} + \gamma_{02(1)}(\text{Staff Relationships})_{j} + \gamma_{12(1)}(\text{Staff Relationships})_{j}{*}(\text{Job Satisfaction})_{ij} + \gamma_{03(1)}(\text{Appreciation})_{j} + \gamma_{13(1)}(\text{Appreciation})_{j}{*}(\text{Job Satisfaction})_{ij} + \gamma_{04(1)}(\text{Collaboration Among Staff})_{j} + \gamma_{14(1)}(\text{Collaboration Among Staff})_{j}{*}(\text{Job Satisfaction})_{ij} + \gamma_{00(2)} + \gamma_{01(2)}(\text{Autonomy and Access})_{j} + \gamma_{10(2)}(\text{Job Satisfaction})_{ij} + \gamma_{11(2)}(\text{Autonomy and Access})_{j}{*}(\text{Job Satisfaction})_{ij} + \gamma_{02(2)}(\text{Staff Relationships})_{j} + \gamma_{12(2)}(\text{Staff Relationships})_{j}{*}(\text{Job Satisfaction})_{ij} + \gamma_{03(2)}(\text{Appreciation})_{j} + \gamma_{13(2)}(\text{Appreciation})_{j}{*}(\text{Job Satisfaction})_{ij} + \gamma_{04(2)}(\text{Collaboration Among Staff})_{j} + \gamma_{14(2)}(\text{Collaboration Among Staff})_{j}{*}(\text{Job Satisfaction})_{ij} + U_{0j(1)} + U_{1j(1)} + U_{0j(2)} + U_{1j(2)}. \tag{5.7}$$

Results

Tables 5.7 and 5.8 show the multilevel multinomial models that were used to analyze predictions of science teacher job satisfaction and school retention strategy factors on teachers' decisions to either stay at a school or move to teach at another school. Results indicate that neither job satisfaction nor retention strategies independently were significantly associated with high school science teacher mobility (see Tables 5.7 and 5.8). Similar results were observed with respect to interactions between job satisfaction and retention strategies association with science teachers' decision to stay or move from a school (see Table 5.8).

Table 5.7
Fixed effects coefficient for multilevel multinomial model describing high school science teachers classified as movers and stayers using composite job satisfaction scores

	Fixed Effects					
	Symbol	Coefficient	Standard Error	Odds Ratio	df	p-value
Intercept	$\gamma_{00(2)}$	-1.909	0.163	0.148	46	0.000
Job Satisfaction	$\gamma_{10(2)}$	-0.186	0.130	0.831	46	0.387

	Random Effects				
	SD	Variance Component	df	Chi-square	p-value
Intercept, $U_{0(2)}$	1.006	1.011	46	41.506	0.320
Intercept, $U_{1(2)}$	0.551	0.304	46	31.681	>.500

Note. SD = Standard Deviation; df = degrees of freedom.

Table 5.8
Fixed effects coefficient for multilevel multinomial model describing high school science teachers classified as movers and stayers using retention strategy factors and composite job satisfaction scores

	Fixed Effects					
	Symbol	Coefficient	Standard Error	Odds Ratio	df	p-value
Intercept	γ_{00}	-1.992	0.227	0.136	42	0.000
Autonomy and Access	γ_{01}	0.316	0.315	1.372	42	0.322
Staff Relationships	γ_{02}	-0.111	0.239	0.895	42	0.645
Appreciation	γ_{03}	-0.344	0.233	0.709	42	0.148
Collaboration Among Staff	γ_{04}	-0.182	0.203	0.833	42	0.375
Job Satisfaction	γ_{10}	-0.155	0.191	0.856	42	0.421
Autonomy and Access * JS	γ_{11}	0.242	0.186	1.274	42	0.201
Staff Relationships * JS	γ_{12}	-0.262	0.174	0.769	42	0.140
Appreciation * JS	γ_{13}	0.188	0.120	1.207	42	0.123
Collaboration Among Staff * JS	γ_{14}	0.291	0.158	1.337	42	0.073

	Random Effects				
	SD	Variance Component	df	Chi-square	p-value
Intercept, $U_{0(2)}$	1.029	1.059	34	40.862	0.194
Intercept, $U_{1(2)}$	0.412	0.169	34	26.463	>.500

Note. SD = Standard Deviation; df = degrees of freedom; JS = Job satisfaction.

Tables 5.9 and 5.10 display relationships between school retention strategies, teacher job satisfaction and science teachers' decisions to either stay at their school or leave the teaching profession. Relationships between job satisfaction and science teacher mobility approached significance at a p-value of 0.053 (Table 5.9). Results indicated no relationships of significance between retention strategies and mobility. These interpretations were highlighted by fixed effect coefficients and standard error statistics that suggest regardless of retention score, teachers were just as likely to stay at their current school or leave the profession the following school year (Table 5.10).

Table 5.9
Fixed effects coefficient for multilevel multinomial model describing high school science teachers classified as leavers and stayers using composite job satisfaction score

	Fixed Effects					
	Symbol	Coefficient	Standard Error	Odds Ratio	df	p-value
Outcome	$\gamma_{00(1)}$	-2.026	0.163	0.132	46	0.000
Job Satisfaction	$\gamma_{10(1)}$	-0.258	0.130	0.772	46	0.053

	Random Effects				
	SD	Variance Component	df	Chi-square	p-value
Intercept, $U_{0(1)}$	0.295	0.087	38	42.232	0.293
Intercept, $U_{1(1)}$	0.122	0.015	38	27.491	>.500

Note. SD = Standard Deviation; df = degrees of freedom.

With respect to interactions between teacher job satisfaction and retention strategies predicting science teacher mobility, only one statistically significant relationship was noted. Table 5.10 shows satisfied science teachers were more likely to stay at schools with higher Appreciation strategy scores than to leave the profession

($\gamma_{13(1)}$ = -0.391, *df* = 42, *p* = 0.000). No associations were observed for interactions between job satisfaction and the remaining retention strategies with science teacher mobility.

Table 5.10

Fixed effects coefficient for multilevel multinomial model describing high school science teachers classified as leavers and stayers using retention strategy factors and composite job satisfaction scores

	Fixed Effects					
	Symbol	Coefficient	Standard Error	Odds Ratio	df	p-value
Intercept	γ_{00}	-2.119	0.155	0.120	42	0.000
Autonomy and Access	γ_{01}	-0.049	0.149	0.952	42	0.745
Staff Relationships	γ_{02}	0.164	0.155	1.178	42	0.297
Appreciation	γ_{03}	0.036	0.076	1.036	42	0.641
Collaboration Among Staff	γ_{04}	0.176	0.144	1.193	42	0.228
Job Satisfaction	γ_{10}	-0.308	0.106	0.735	42	0.006
Autonomy and Access * J.S.	γ_{11}	-0.067	0.084	0.936	42	0.430
Staff Relationships * J.S.	γ_{12}	-0.050	0.096	0.951	42	0.607
Appreciation * J.S.	γ_{13}	-0.391	0.071	0.676	42	0.000
Collaboration Among * J.S. Staff	γ_{14}	0.070	0.114	1.072	42	0.545

	Random Effects				
	SD	Variance Component	df	Chi-square	p-value
Intercept, $U_{0(1)}$	0.209	0.043	34	40.404	0.208
Intercept, $U_{1(1)}$	0.151	0.023	34	23.577	>.500

Note. SD = Standard Deviation; df = degrees of freedom; JS = Job satisfaction.

Discussion

Policy analysts and science education stakeholders may concede that to develop effective policies one must incorporate the latest consensus and research evidence concerning *best practice* for retention of highly qualified science teachers (Knapp, 2003). Prior research evidence also serves as a vehicle to inform education stakeholders of different avenues to study the complexities of teacher mobility. For this study I used non-linear models to examine the complex relationships among school retention strategies, science teacher job satisfaction, and science teacher mobility. Specifically, multinomial modeling allowed me to examine reasons teachers either chose to stay at a school, move to another school, or leave the profession. To distinguish predictor variables' associations with teacher mobility, I used multilevel analyses. Two-level analyses were used based on the teacher- and school-level variables of interest for this study.

Findings from this study did not reveal any relationships between school retention strategies and high school science teacher mobility decisions. These findings were comparable to previous results that examined relationships between school retention strategies and school retention rates using linear models. Furthermore, no relationship appeared to exist between science teacher job satisfaction and teachers' decisions to either move from or stay at a school. Although multilevel analyses did not reveal a relationship of significance between job satisfaction and teachers' decision to either leave the profession or stay at a school, an association was present.

Interactions among first- and second-level predictor variables and teacher mobility did not reveal any relationships of significance, with the exception of job satisfaction and strategies related to Appreciation. Specifically, satisfied science teachers were more likely to remain at schools that expressed and showed appreciation for teachers than to leave the profession. These results were comparable to previous findings that examined the relationships between school Appreciation scores and retention status in specific school contexts.

The findings from this study have important implications regarding high school science teacher mobility outcomes in the state of Texas. First, no relationships of significance between strategies and mobility indicate that retention strategies currently implemented at Texas schools are not doing much to retain teachers. District administrators and school principals are encouraged to work together to evaluate aspects of the school environment (e.g., school policies, strategies, and working conditions) to inform development of strategic retention plans targeting science teachers. In addition, state- and district level administrators are encouraged to provide opportunities for professional development to assist principals in creating retention plans.

Second, the absence of significant relationships between teacher job satisfaction and mobility refutes prior investigations

> [that] have reported highly satisfied teachers intend to remain in teaching, as compared to dissatisfied teachers who indicate that they have intentions to leave teaching (e.g., Bacharach & Baumberger, 1990; Heyns, 1988; Mitchell, Ortiz, & Mitchell, 1987; Stockard & Lehman, 2004). This investigation, in contrast, used

> actual numbers to examine retention, [migration, and attrition] of high school science teachers and found no significant relationship between teachers' job satisfaction and [mobility outcomes]. These findings thus suggest a gap between what teachers say they intend to do and what they actually do in terms of leaving their teaching positions. (Stuessy et al., 2010, p. 27)

Finally, these findings suggest the importance of considering the satisfaction levels of teachers with respect to the school environment. Specifically, satisfaction appears to be related to a schools' capacity to show and express appreciation for science teachers. This relationship was strengthened when taking into account a science teacher's decision to either leave the profession or remain at a school. This finding emphasizes the importance of incorporating appreciation strategies in retention plans created and enforced by school principals. Therefore, dialogue and collaboration among district administrators, principals, and teachers will be necessary to (a) reduce dissonance regarding school environmental policies among education stakeholders, and (b) create a school culture that appreciates teachers for their professional contributions. These efforts may improve satisfaction levels and retention of high school science teachers.

Limitations

A few important limitations materialized during the implementation of this study. First, a delimitation of the sampling plan designed by McNamara and Bozeman (2007) was to select sample schools only from the state of Texas. Implications emerging from results presented in this study are therefore limited to the state of Texas (Stuessy et al., 2010). However, research methods used during this study (e.g., Administrator Interview Protocols, TPSST, school- and state-level archival data) are generalizable to other states desiring to investigate associations between school retention strategies, science teacher job satisfaction, and science teacher mobility (Stuessy et al., 2010). Use of these research methods provides the opportunity for expanding the investigation of the TPC beyond Texas boundaries.

Second, low numbers of retention strategies reported by each high school principal presented limitations to subsequent analytic methods (i.e., factor analysis and non-linear models) used to examine relationships between major study variables. While conducting factor analysis allowed me to identify strategies that explained approximately 70.0% of the variance in responses on the rubric, few strategies emerged that could inform the design of robust strategic retention plans targeting high school science teachers. This was particularly noted for Appreciation. Although the interaction of Appreciation with job satisfaction and a science teacher’s decision to either stay at a school or leave the profession was significant, factor analysis extracted only one strategy to inform creation of school retention plans.

CHAPTER VI

SUMMARY OF FINDINGS AND POLICY RECOMMENDATIONS

Highly qualified science teachers play a central role in preparing the next generation of students “to learn, live, and work in a technological, scientifically advanced society” (NAS, 2007; NCEE, 1983; Richardson & Stuessy, 2010; Stuessy, 2009, p. 1). Understanding the complex relationships among factors associated with retention is important for decreasing turnover of science teachers in Texas schools. In light of the current losses of science teachers, as well as forecasted increases in retirement and current reductions in force, this dissertation sought to provide policy analysts and science education stakeholders a description about *where are we* with respect to retention of public high school science teachers in Texas. Below, I provide a summary of the empirical research detailed in Chapters III, IV, and V. Chapter summaries are followed by implications for policy initiatives derived from empirical findings. Implications presented in this dissertation are limited to the state of Texas.

The purpose of Chapter III was to describe *where are we* in regards to high school science teacher mobility. Teacher mobility refers to the employment outcomes of retention, migration, and attrition (Bozeman, 2010). Mobility patterns, as well as hiring patterns of science teachers are important behaviors noted in the context of reciprocal determinism (Bandura, 1977). Findings indicate that schools lose an estimated one out of four science teachers each year, increasing to one out of three teachers by the end of two years. Findings from these analyses corroborate previous reports that suggest schools are primarily losing young, novice science teachers and experienced science teachers approaching retirement (Darling-Hammond, 2000; Kirby & Grissmer, 1993). Evidence also indicates science teacher demographics in schools do not mirror the racial and ethnic diversity of student populations in Texas. White teachers typically lead science classrooms and are hired by schools to fill vacancies. Regarding gender, findings suggest male science teachers are more likely to migrate from a school, while female science teachers are more likely to either stay at a school or depart the profession.

Using the school as the unit of analysis, Chapter IV examined the relationships among school environment variables, i.e., retention strategies, retention challenges, school size, and minority student enrollment proportion (MSEP), with science teacher retention behavior. Findings suggest that although Texas has a broad range of retention strategies, most schools do not posses their own gamut of strategies. Furthermore, findings suggest no relationships of significance exist between retention strategies and science teacher retention. While a variety of retention challenges for high school science teachers is occurring across schools, individual schools are typically not confronted with a large spectrum of challenges.

With respect to school context and retentions status, findings suggest High-Retention schools either use a diverse range of retention strategies to keep high school science teachers or are more aware of strategies *that work* to retain science educators in contrast to respective Low-Retention schools. High-Retention schools are also more aware and active in addressing challenges to retention science teachers in contrast to

Low-Retention schools. Science teacher departures for employment opportunities outside of education appear to be a top concern for High-Retention Texas schools.

Chapter V focused on exploring relationships among high school science teacher job satisfaction, science teacher mobility, and school retention strategies. The latter two variables were previously analyzed in Chapters III and IV, respectively. Incorporation of the teacher job satisfaction variable allowed me to analyze each domain within the reciprocal determinism framework (i.e., cognition, behavior, and environment). Findings indicate that generally no relationships of significance occurred among teacher- and school- predictor factors, either directly or via interaction with each other, to teacher mobility. The only relationship of significance indicates that satisfied teachers are more likely to remain at schools that show and express appreciation than to leave the teacher professional continuum (TPC).

Policy Recommendations

Empirical research serves as the cornerstone for reform efforts in education. "[Education stakeholders] cannot expect reform efforts in education to have significant effects without research-based knowledge to guide them" (NRC, 2002, p. 1). In the following, I present policy recommendations that are based on empirical findings included in Chapters III, IV, and V of this dissertation. Findings and recommendations reported in this study "lay the groundwork for dialogue, development, and dissemination of creative solutions [to retain]…science teachers" (Richardson & Stuessy, 2010, p. 8). As some implications of results are similar, recommendations for Chapter V are integrated into the Chapter IV discussion. Policy recommendations are designated at the state, district and school levels.

Chapter III findings suggest high school administrators need state- and district-level administrator support to design new or modify current policies that target retention of Novice science teachers. Such policies may include streamlining other aspects of the TPC that are associated with retention and science instruction (i.e., induction support, professional development, and working conditions). Similar efforts are needed to improve support of underrepresented groups (i.e., ethnic minority teachers and male teachers) with the addition of aggressive recruitment strategies for these demographics. Also, district- and school- administration should consider providing differential roles for capable teachers that encourage professional activity and leadership beyond the classroom.

With respect to Chapter IV, findings suggest that high school principals need professional development support from state- and district-level administration to develop and enforce strategic retention plans to retain science teachers. Also, dialogue among district- and school- level administrators and teachers will be necessary to (a) reduce dissonance regarding school environment policies, thereby increasing teacher job satisfaction, and (b) address retention challenges for science teachers. This policy recommendation also emerges from evidence specific to school appreciation for teachers presented in Chapter V. Dialogue will have to occur in such a way as to allow science teachers and lower administration to speak candidly without fear of compromising their positions within a school. Finally, state-level administration should consider recognizing schools that successfully retain highly qualified science teachers. I believe schools that are able to implement policies and strategies that effectively keep high-quality teachers reflect a school culture that values teachers both professionally and personally.

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APPENDIX A

TEXAS POLL OF SECONDARY SCIENCE TEACHERS

1. (a) Have you formally participated in recruiting new science teachers since the fall of 2006? (Please enter a check on just one line below).

____ Yes (If yes, go to question #1b.)

____ No (If no, go to questions #2.)

(b) Please indicate all of the ways that you have formally participated in the recruitment of new science teachers. (Please check all that apply).

____a. formal interviews at the school site

____b. informal visits with perspective science teachers

____c. recruitment trips outside school walls

____d. policy meetings specific to science

____e. review job applications for prospective science teachers

____f. Other (Please briefly explain).

2. (a) Have you participated in the induction/mentoring of new science teachers since the fall of 2006? (Please enter a check on just one line below).

____ Yes (If yes, go to question #2b)

____ No (If no, go to question #3)

(b) Please indicate all of the ways that you have participated in the induction/mentoring of new science teachers. (Please check all that apply).

____a. assisted with orientation to school policies

____b. assisted with classroom management

____c. observed a new science teacher teaching a science class

____d. modeled teaching for a new science teacher ____e. provided a new science teacher with a science lesson

____f. developed a science lesson with a new science teacher

____g. performed formal mentoring duties with a new science teacher

____h. other (Please briefly explain.)

3. (a) Since the fall of 2006, have you served in a leadership role? (Please enter a check on just one line below).

____ Yes (If yes, go to question #3b)

____ No (If no, go to question #4)

(b) Please indicate the leadership roles you have held since the fall of 2006. (Please check all that apply).

____ a. Science department chair

____ b. Science curriculum writer

____ c. Science club/organization sponsor

____ d. Mentor to a science teacher

____ e. Member of a science teacher professional organization

____ f. Presenter at a science workshop, conference, or training session

____ g. Mentor to a teacher who is not a science teacher

____ h. Subject team leader in a subject other than science

____ i. Member of a teacher professional organization that is not specifically science-related

____j. Member of a district-level decision-making committee

____ k. Other leadership role. (Please specify below.)

4. Since the fall of 2006, in which of the following types of professional development opportunities have you participated? (Please enter a check in all lines below that apply to you).

____ a. Strategies for teaching science content

____ b. Strategies for teaching science using technology

____ c. Strategies for teaching science using the Texas Essential Knowledge and Skills (TEKS)

____ d. Strategies for preparing students to master the Texas Assessment of Knowledge and Skills (TAKS) objectives

____ e. Strategies for teaching science to students with special needs

____ f. Strategies for the use of laboratory in teaching science

____ g. Strategies for teaching science by inquiry

____ h. None of the above

____ i. Other. (Please specify below.)

5. (a) Since the fall of 2006, in which of the following activities have you engaged that were specific to science or science education? (Please enter a check in all lines below that apply to you).

____ a. Teacher research on innovative practice in science

____ b. Peer observations of other science teachers

____ c. Graduate studies in a science-related field

____ d. Educator study groups in science

____ e. Professional science teaching associations

____ f. Curriculum writing in science

____ g. Mentoring of science student teachers

____ h. Other (Please specify below.)

(b) Since the fall of 2006, in which of the following professional activities have you engaged that were not specific to science? (Please enter a check in all lines below that apply to you).

____ a. Teacher research on innovative practice in a content area other than science

____ b. Peer observations of teachers other than science teachers

____ c. Graduate studies in an area that is not science related

____ d. Educator study groups in a content area other than science

____ e. Teaching professional associations that are not science specific

____ f. Curriculum writing in a content area other than science

____ g. Mentoring of student teachers in content areas other than science

____ h. Other (Please specify below.)

6. In a typical semester, how often do you informally meet (that is, not during a scheduled science department meeting) with other science teachers at your school about issues related to classroom science teaching? (Please enter a check on just one line below).

____ a. Daily

____ b. Once a week

____ c. Twice a week

____ d. Once a month

____ e. Twice a month

____ f. Once a semester

____ g. Twice a semester

____ h. Almost never

7. Overall, how satisfied are you with your decision to become a high school science teacher? (Please enter a check on just one line below).

_____ a. Very satisfied

_____ b. Satisfied

_____ c. Dissatisfied

_____ d. Very dissatisfied

8. How much do you agree with this statement: Improving student achievement in science is a team effort at this school? (Please enter a check on just one line below).

_____ a. Strongly agree

_____ b. Agree

_____ c. Disagree

_____ d. Strongly disagree

9. How satisfied are you with the level of cooperation and collegiality among all the teachers at this school? (Please enter a check on just one line below).

_____ a. Very satisfied

_____ b. Satisfied

_____ c. Dissatisfied

_____ d. Very dissatisfied

10. How satisfied are you with the way your science program contributes to the career development of students at this school? (Please enter a check on just one line below).

_____ a. Very satisfied

_____ b. Satisfied

_____ c. Dissatisfied

_____ d. Very dissatisfied

11. How satisfied are you with the decisions you can make about the instructional methods you use in your own science classroom? (Please enter a check on just one line below).

____ a. Very satisfied

____ b. Satisfied

____ c. Dissatisfied

____ d. Very dissatisfied

12. How satisfied are you with the support you receive from the school to have your students attend informal science activities, such as field trips, visits to museums, and off-campus activities at informal science institutions? (Please enter a check on just one line below).

____ a. Very satisfied

____ b. Satisfied

____ c. Dissatisfied

____ d. Very dissatisfied

13. How satisfied are you with the options that you have at your school for participating in science-specific professional development? (Please enter a check on just one line below).

____ a. Very satisfied

____ b. Satisfied

____ c. Dissatisfied

____ d. Very dissatisfied

14. How satisfied are you with the support provided by your school for you to participate in professional development? (Please enter a check on just one line below).

____ a. Very satisfied

____ b. Satisfied

_____ c. Dissatisfied

_____ d. Very dissatisfied

15. How satisfied are you with your science laboratory facilities? (Please enter a check on just one line below).

_____ a. Very satisfied

_____ b. Satisfied

_____ c. Dissatisfied

_____ d. Very dissatisfied

16. How satisfied are you with your science laboratory equipment? (Please enter a check on just one line below).

_____ a. Very satisfied

_____ b. Satisfied

_____ c. Dissatisfied

_____ d. Very dissatisfied

17. How satisfied are you regarding the recognition you receive for your science teaching efforts at this school? (Please enter a check on just one line below).

_____ a. Very satisfied

_____ b. Satisfied

_____ c. Dissatisfied

_____ d. Very dissatisfied

18. How satisfied are you with your current teaching assignment? (Please enter a check on just one line below).

_____ a. Very satisfied

_____ b. Satisfied

_____ c. Dissatisfied

_____ d. Very dissatisfied

19. How would you rate your personal level of safety at this school? (Please enter a check on just one line below).

____ a. Excellent personal safety

____ b. Good personal safety

____ c. Fair personal safety

____ d. Poor personal safety

20. How satisfied are you with the administrative communication you receive about expectations for your teaching in this school? (Please enter a check on just one line below).

____ a. Very satisfied

____ b. Satisfied

____ c. Dissatisfied

____ d. Very dissatisfied

21. Please provide your full name.

____

First	Middle	Last	Maiden (if applicable)

22. Including this year (2007-2008) as one year, how long have you taught science at this school? (Please enter the number of years in the box below.)

# of years

VITA

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